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Tenth Summer Conference on

GENERAL TOPOLOGY AND APPLICATIONS

178 pg

Vrije Universiteit

AMSTERDAM

94

August 15–18

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TU Delft

Technische Universiteit Delft

vrije Universiteit *amsterdam*

STEVIG ONDER DE STORMEN

1913

FACULTEIT DER
ECONOMISCHE WETENSCHAPPEN
ERASMUS UNIVERSITEIT ROTTERDAM

Thomas Stieltjes Instituut

AKZO

N·H

NORTH-HOLLAND

An Imprint of Elsevier Science

IBM

Kluwer academic publishers

CWI Centrum voor Wiskunde en Informatica

Koninklijke Nederlandse Akademie
van Wetenschappen

NWO

Nederlandse Organisatie
voor Wetenschappelijk
Onderzoek

Baruch College (CUNY)
City College of New York (CUNY)
College of Staten Island (CUNY)
Long Island University (C. W. Post Campus)
New York Academy of Sciences (Section of Mathematics)
Queens College (CUNY)
Slippery Rock University
Vereniging Trustfonds Erasmus Universiteit Rotterdam
European Research Office of the U.S. Army
Office of Naval Research Eurpean Office

Contents

Introduction

The Organizing Committee of the Amsterdam Summer Conference on General Topology and Applications welcomes you. We are very glad that you participate and trust that you will find this conference extremely stimulating, both mathematically and socially.

The Summer Conferences have a tradition of ten years now: from a modest beginning in 1984 at City College of New York, it has grown to be the second largest annual conference in the subject. Proceedings of all but the 1984 conference have appeared or are in process of being published through the New York Academy of Sciences and through Marcel Dekker. The 1994 conference proceedings will be published through the New York Academy of Sciences.

To emphasize the breadth of topology there will be four special sessions during this conference: topology and descriptive set theory, set theoretic topology, infinite-dimensional and geometric topology, and continuum theory and dynamics. In addition there will be minicourses on continuum theory and dynamics, and topology and descriptive set theory, the lecture notes of which are published as a special issue of the journal *Topology and its Applications*.

The Organizing Committee is pleased to thank the sponsors for their financial support and the Vrije Universiteit for its hospitality. We also thank the invited speakers of the main addresses and the minicourses for their willingness to participate and their enthusiasm. It is also our pleasure to thank Ralph Kopperman for his constant support and valuable advice.

The organizing committee:
J. M. Aarts
E. Coplakova
F. van Engelen
K. P. Hart
M. A. Maurice
J. van Mill
M. Titawano

General Information

1. Conference Location

The conference will take place at the Mathematics and Physics building W&N of the Vrije Universiteit, rooms G 0.76, G 0.88, F 1.23, F 1.53, M 1.29, M 1.43, KC 1.37 and KC 1.59 (see the floor plan on page 16). Rooms G 0.76 and G 0.88 are at ground level (first floor), rooms F 1.23, F 1.53, M 1.29 and M 1.43 are at level 1 (second floor), and rooms KC 1.37 and KC 1.59 have entrances at both levels. Smoking is not permitted in the buildings of the Vrije Universiteit.
All plenary sessions are in Room KC 1.37.

2. Registration and Information Desk

If you need assistance of any kind: at all times during the conference there will be somebody available at the registration and information desk in room G 0.88. The desk can also be reached by telephone, number (020)-6447147.

3. Conference Materials

With your registration, you should have received:

- This program
- Yellow Pages Visitors Guide
- A Special Issue of *Topology and its Applications* containing the lecture notes for the mini-courses
- A streetplan of Amsterdam
- A map of Amsterdam public transportation lines
- Tourist information Amsterdam
- Information about the *VOC-ship* (see 9)
- An envelope containing:
  - Welcome Party tickets (see 9)
  - Lunch tickets (see 8)
  - Invitation to the Reception (see 9)
  - Conference Dinner ticket (see 9)
  - Public Transportation ticket (see 10)

The envelope should also contain reception invitations, dinner tickets, and public transportation tickets for registered accompanying persons.

4. Book Exposition

During the conference there will be an exposition of books on topology and related fields in room G 0.76. The exposition is organised by the university bookstore.

5. Conference Proceedings

The conference proceedings will be published through the New York Academy of Sciences. Information on how to submit a paper and how to obtain a copy of the proceedings will be provided at the conference.

6. Facilities

- E-mail: If you need to check your e-mail, please contact the registration and information desk in room G 0.88. Upon request, you will receive a login name and a password. In room S 5.45 there are several X-terminals reserved for the participants of the conference.
- Post office: there is a small post office in the main building of the Vrije Universiteit (opening hours 9:00-12:00 and 13:00-16:00).
- Banks: There is a branch of ABN-AMRO Bank at the corner of Buitenveldertselaan and A.J. Ernststraat.

7. Coffee

During the breaks in the program you may obtain free coffee, tea and a (limited) variety of soft drinks in the lounge in front of the ground level entrance of room KC 1.37.

8. Breakfasts and Lunches

- Breakfast is served each conference day, 8:15–9:00, in the Restaurant of the W&N building of the university (see the floor plan on page 16). Costs are included in the conference fee. On Friday morning only, Hospitium residents may order breakfast in the Hospitium Breakfast Room (Dfl. 10,–).
- Lunch is served each conference day, 12:00–13:00, in the Restaurant. Costs are included in the conference fee, but you must pay by means of the lunch tickets which you obtain with your registration (for each day a different color).

9. Social Events

- Welcome Party: a welcome party will be held at the Hospitium, the guest house of the Vrije Universiteit, on Sunday, 18:00–22:00. With your registration, you have received 5 tickets for free drinks. These tickets can also be used earlier on Sunday for free coffee, snacks, etc.
- Boat Trip and Reception: the Mayor and Aldermen of Amsterdam and the President of the Royal Netherlands Academy of Arts and Sciences will offer a reception to participants and registered accompanying persons of the conference on Monday, August 15, 18:30–19:30; official invitations are contained in the envelope that you have received at registration. The reception will take place on the VOC-ship *Amsterdam*, a replica of an 18th-century East Indiaman; you can find some historical information about the ship and the VOC (Dutch East India Company) in the leaflet *nederlands Scheepvaartmuseum* that you have received with your conference materials.

  The conference organization has arranged for sightseeing boats to take you to the *Amsterdam*. These boats will leave from the *Zuider Amstel*-canal from near the bridge at Parnassusweg/Stadionkade (see your street plan) between 17:00 and 17:15. To get to the mooring area of the sightseeing boats, you can either take bus 63 or walk from the Vrije Universiteit (about

15–20 minutes). If you decide to come to the VOC-ship on your own, we refer to the VOC-ship leaflet for information.
Return transportation has NOT been arranged for: just use your travel card (see 10).

- Conference Dinner: the conference dinner will be held on Wednesday, August 17. It will be a buffet-style *rijsttafel* dinner, with a great variety of Indonesian dishes. You can put together your own meal, and also for vegetarians there is ample choice. The dinner ticket covers five free drinks. Additional drinks will be available at moderate prices.
The dinner will take place in *Het Werkteater*, Oosterburgergracht 75, and starts at 19:00. The buffet starts at 20:00.
Het Werkteater can be reached by bus from the Central Station: by bus 22, departing from the platform in front of the Central Station and by bus 28, departing from the De Ruyterkade. You are advised to ask the busdriver where to get off for *Het Werkteater*.
If you feel like it, you can also take a walk from the Central Station to *Het Werkteater*. The walk will take some 20 minutes. From the Central Station you go east and follow the Prins Hendrikkade. After about 7 minutes you will see the VOC ship (of Monday's reception) to your left and the Montelbaanstoren to your right. The Prins Hendrikkade continues as Kattenburgergracht, Wittenburgergracht and, finally, Oostenburgergracht, where *Het Werkteater* is located (consult your street plan).
Het Werkteater was erected in 1952 and originally served as a theater for the personnel of the Stork shipyard. The surroundings are the former rope-yard of the VOC. Alongside the walking route there are many old buildings of the VOC.

10. Public Transportation

With your registration, you have received a five-day travel card for bus, tram and metro, and a map of all public transportation lines; public transportation routes are also indicated on the detailed Amsterdam street plan you have received. Machines (yellow) to validate the travel card can be found in all trams and metro stations; on buses (and trams, also) the driver can validate the ticket for you. Upon validation, the ticket is valid for a period of 5 days (120 hours). *Within the Amsterdam city limits*, the ticket can be used on *all* trains, buses, trams, and metros (e.g., going south from the Vrije Universiteit, the ticket is valid until the *Uilenstede*-stop (*Hospitium*), but not beyond).

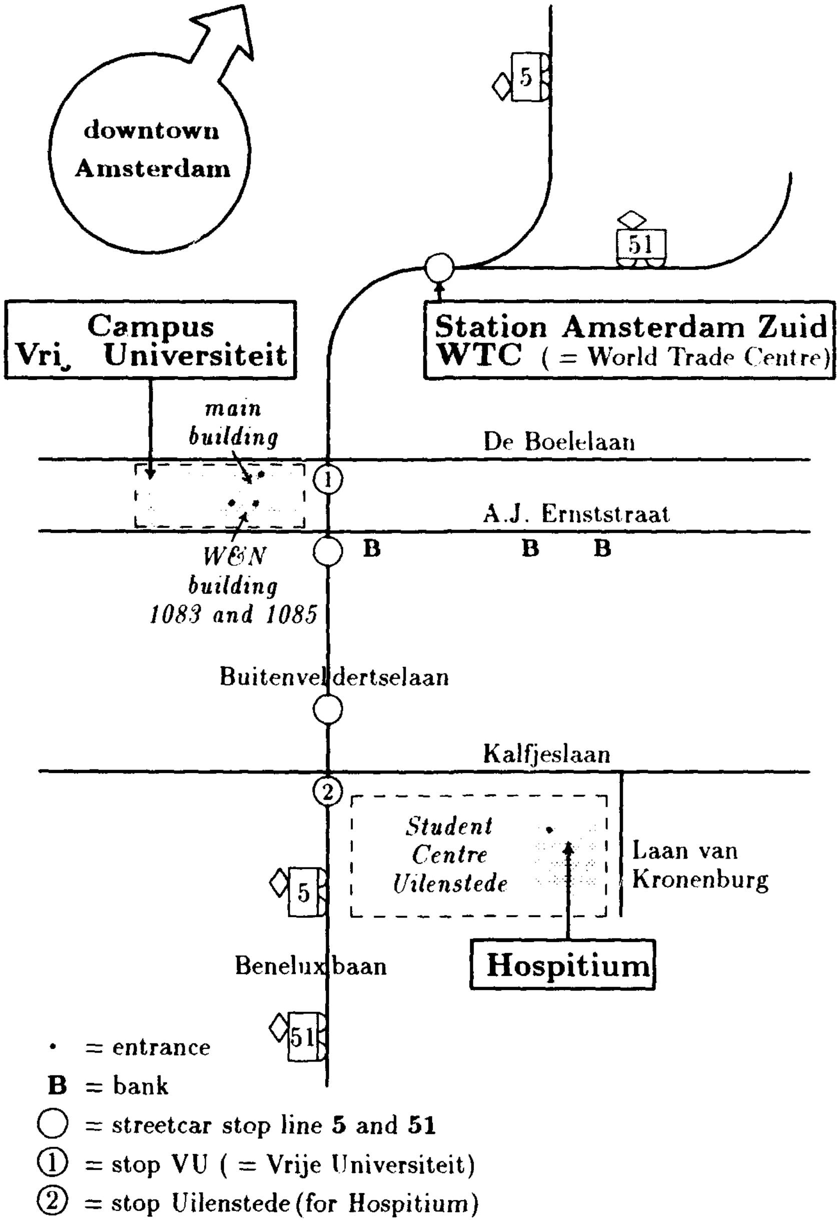
11. T-shirts

Conference T-shirts can be purchased at the Registration and Information Desk at Dfl. 20,- each. If supply runs out then additional T-shirts can be ordered. You should place your order *by noon Wednesday*, the T-shirts will then be available Thursday afternoon.

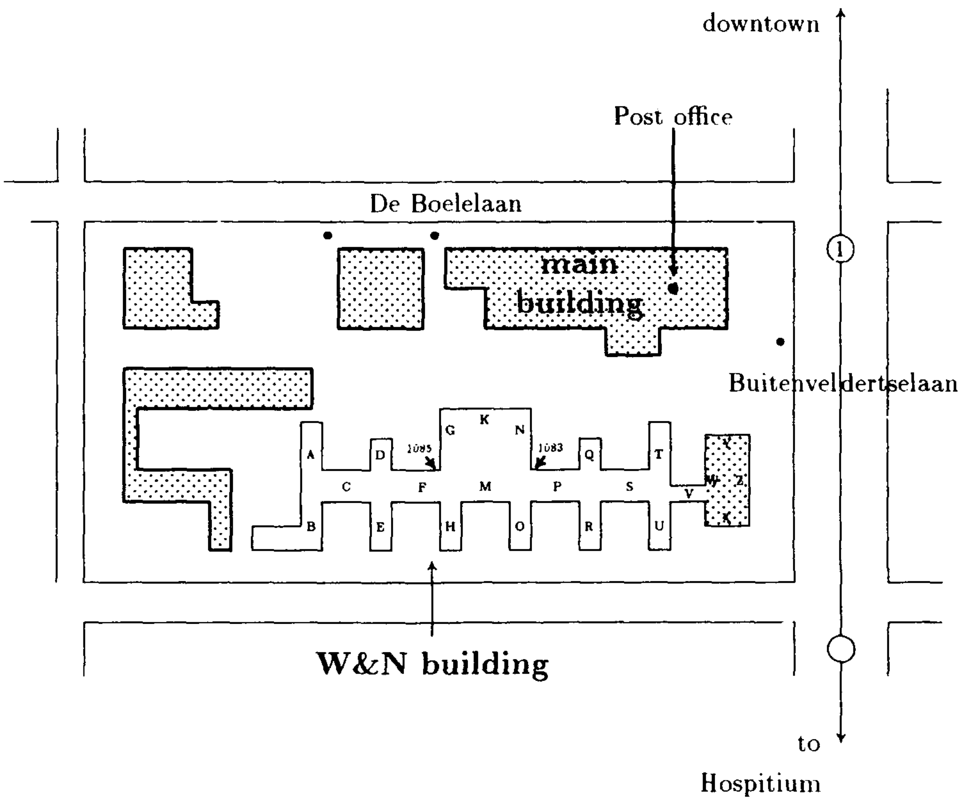
12. Addresses and Telephone Numbers

- Registration and Information Desk, telephone (during conference hours): (020)-6447147.
- Vrije Universiteit Mathematics Department, De Boelelaan 1081, 1081 HV Amsterdam, telephone (during office hours): (020)-4447700.
- Hospitium, Laan van Kronenburg 9, 1183 AS Amstelveen, telephone: (020) 4449270.

MAPS



Vrije Universiteit and Hospitium

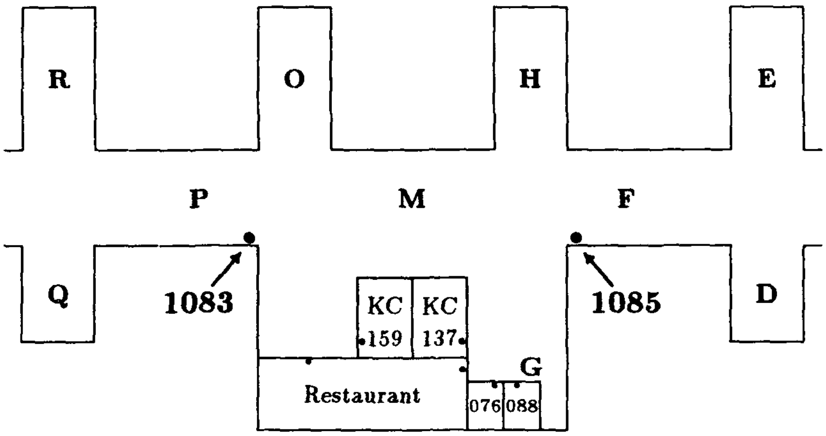


○ = streetcar stop lines **5** and **51**

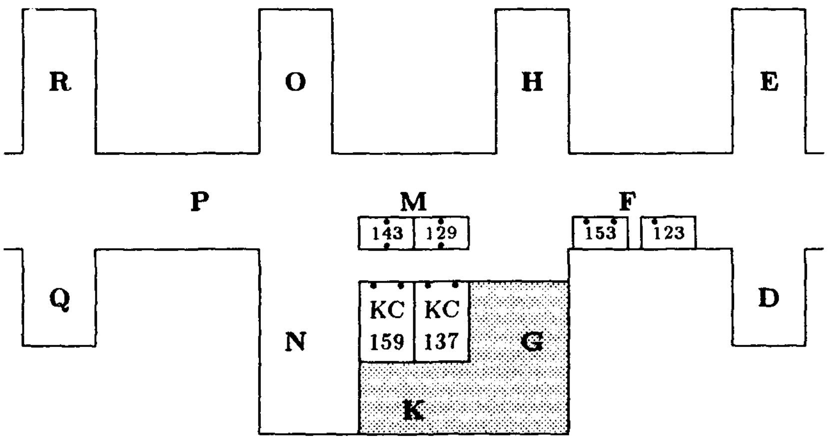
① = streetcar stop VU = Vrije Universiteit

• = entrance

VU Campus



Conference site – ground level (first floor)



Conference site – first level (second floor)

• = entrance

Conference site W&N building

PROGRAM

Opening

The conference will be opened by Dr. J. Donner, member of the Board of Directors of the Vrije Universiteit, in lecture room KC 1.37 at 9:15.

Invited speakers

Opening lectures

J. W. Milnor — *Local Connectivity in Holomorphic Dynamics* MON 9:30–10:30, KC 1.37
M. E. Rudin — *A Few Old Problems, Solved and Unsolved* MON 11:00–12:00, KC 1.37

Minicourses

A. Kechris — *Topology and Descriptive Set Theory*
MON 14:55–16:30 and WED 13:30–15:05, KC 1.37
Ph. L. Boyland — *Topological Methods in Surface Dynamics*
TUE 13:30–15:05 and THU 10:35–12:10, KC 1.37

Set Theoretic Topology

B. Balcar — *Topologies on Complete Boolean Algebras* MON 13:30–14:30, KC 1.37
A. Dow — *Iteratively Adding Reals and Topology* TUE 10:25–11:10, KC 1.37
S. Todorčević — *Covering Properties of Aronszajn Orderings* TUE 11:15–12:00, KC 1.37
J. Pelant — *Remarks on Spaces of Continuous Functions* THU 15:35–16:20, KC 1.37

Continuum Theory and Dynamics

F. Takens — *Topological Conjugacies, Moduli, and Time Series*
TUE 15:30–16:30, KC 1.37
S. van Strien — *Thin but Heavy Sets* WED 10:25–11:10, KC 1.59
L. G. Oversteegen — *Invariant Subsets of Planar Mappings* WED 11:15–12:00, KC 1.59
K. Kuperberg — *Generalized Counterexamples to the Seifert Conjecture*
THU 15:35–16:20, M 1.29

Topology and Descriptive Set Theory

A. W. Miller — *Descriptive Set Theory and Forcing* TUE 9:00–10:00, KC 1.37
R. D. Mauldin — *Some Problems in Descriptive Set Theory* TUE 10:25–11:10, KC 1.59
H. Becker — *Solution to Problem 1074* TUE 11:15–12:00, KC 1.59

Infinite-dimensional and Geometric Topology

R. Pol — *On Some Problems Concerning Weakly Infinite-Dimensional Spaces*
WED 9:00–10:00, KC 1.37
T. Dobrowolski — *The Absolute Retract and Fixed-Point Properties of Convex Sets, Examples of Cauty and Roberts and Their Aftermath*
WED 10:25–11:10, KC 1.37
H. Toruńczyk — *A Theorem of Borsuk-Ulam Type and its Application to Game Theory* WED 11:15–12:00, KC 1.37
H. Gladdines — *The Set of Compact ANRs in the Plane* THU 15:35–16:20, KC 1.59

Closing Lecture

I. Moerdijk — *Groupoids, Local Equivalence Relations and Monodromy*
THU 16:30–17:30, KC 1.37

Contributed talks

Fariborz Azarpanah - *On Almost P-spaces.* THU 9:00-9:20, M 1.43

Richard N. Ball - *Projective Flows 2.* WED 15:55-16:15, [illegible]

Zoltan T. Balogh - *A Small Dowker Space in ZFC.* TUE 17:30-17:50

A. P. Bredimas - *Exotic Set-Theory and Topology — A Short Survey.* TUE 17:55-18:15, [illegible]3

Jörg Brendle - *Tightness in Products of Fans and Families of Functions in* ω^{λ}. THU 9:00-9:20, KC 1.59

Lawrence Michael Brown - *A Bitopological View of Some Cardinal Functions on Stably Compact Spaces.* TUE 11:15-11:35, M 1.43

Bruce Burdick - *The Asymmetric Hyperspace of a Bitopological Space.* TUE 11:40-12:00, M 1.43

Zvonko Čerin - *Approximate Fibrations.* THU 9:50-10:10, M 1.29

M. G. Charalambous - *Direct Limits of Frames and Dimension.* TUE 10:50-11:10, F 1.53

Alex Chigogidze - *Pseudo-Boundaries and Pseudo-Interiors of Menger Compacta.* THU 14:25-14:45, M 1.43

Krzysztof (Chris) Ciesielski - *Topologies Making a Given Ideal Nowhere Dense or Meager, II.* THU 16:00-16:20, M 1.43

Krzysztof Ciesielski - *The Jordan Curve Theorem for a Funnel in 2-dimensional Semiflows.* WED 17:15-17:35, KC 1.59

Peter Collins - *On Submaximal Spaces.* TUE 17:05-17:25, M 1.43

W. Wistar Comfort - *Realcompactness in the Bohr Topology.* WED 11:15-11:35, M 1.43

Ákos Császár - *m-Proximities.* TUE 10:25-10:45, M 1.43

Francesco S. De Blasi - *Topological Properties of Nonconvex Differential Inclusions.* THU 13:55-14:15, F 1.53

Julian Dontchev - *On Submaximal and Related Spaces.* TUE 16:40-17:00, M 1.43

Edwin Duda - *Products of Confluent Maps.* THU 13:30-13:50, M 1.29

Adalberto García-Máynez - *Special Uniformities.* TUE 16:40-17:00, F 1.53

M. Isabel Garrido - *Algebraic Properties of the Uniform Closure on Spaces of Continuous Functions.* TUE 17:30-17:50, M 1.29

Dimitrios Georgiou - *The Property of* τ*-Universality.* THU 9:00-9:20, M 1.29

Wiesław Główczyński - *Topological Aspects of the Maharam Measure Control Problem.* TUE 17:55-18:15, M 1.43

Christopher Good - *Topologizing Sets so that Permutations are Autohomeomorphisms.* TUE 17:30-17:50, M 1.43

Ivan Gotchev - $\mathcal{P}$*-closed, Sequentially* $\mathcal{P}$*-closed and Absolutely* $\mathcal{P}$*-closed Spaces.* WED 17:15-17:35, KC 1.37

Douglass L. Grant - *Recent Progress on the Wallace Problem.* TUE 16:40-17:00, KC 1.59

Gary Gruenhage - *Sub-Ostaszewski Spaces.* TUE 17:05-17:25, KC 1.37

Renata Grunberg - *Forcing and Normality, III.* WED 16:20-16:40, KC 1.37

James N. Hagler - *Projective Flows 1.* WED 15:30-15:50, KC 1.59

Roger W. Hansell - *Some Properties of General Descriptive Spaces.* WED 16:50-17:10, M 1.43

Robert W. Heath – *Topological Semi-Groups on Linearly Ordered Topological Spaces.* TUE 17:30-17:50, KC 1.59

Ulrich Heckmanns – *On the Topology of Ultrametric Spaces.* WED 17:15-17:35, F 1.53

Melvin Henriksen – *Still More on the Intermediate Value Theorem for Polynomials with Coefficients in a Ring of Continuous Functions.* TUE 16:40-17:00, M 1.29

Salvador Hernández – *Ring of Continuous Functions on Locally Compact Abelian Groups.* TUE 11:40-12:00, M 1.29

Petr Holický – *A Larg: Class of Analytic Topological Spaces and Descriptive Topology.* WED 10:25-10:45, M 1.29

H. H. Hung – *Factorization of Metrizability.* THU 15:35-15:55, F 1.53

Worthen N. Hunsaker – *The Nachbin Quasi-Uniformity and the Skula Topology.* TUE 17:05-17:25, F 1.53

S. D. Iliadis – *Metrically Universal Spaces.* THU 9:25-9:45, M 1.29

Alejandro Illanes – *Hyperspaces which are Products.* THU 13:55-14:15, M 1.29

Gerard Itzkowitz – *Iwasawa Type Decompositions.* TUE 10:25-10:45, M 1.29

Jakub Jasinski – *Topologies Making a Given Ideal Nowhere Dense or Meager, I.* THU 15:35-15:55, M 1.43

I. Juhász – *Spaces with no Smaller Normal or Compact Topologies.* TUE 16:40-17:00, KC 1.37

Lúcia R. Junqueira – *Forcing and Normality, II.* WED 15:55-16:15, KC 1.37

Vladimir Kanovei – *On External Scott Algebras in Nonstandard Models of Peano Arithmetic.* WED 11:40-12:00, M 1.29

František Katrnoška – *Some Properties of the Rings of Continuous Functions Defined on Stonean Spaces.* TUE 17:05-17:25, M 1.29

Judy Kennedy – *Generic Behavior of Homeomorphisms on Manifolds.* WED 16:20-16:40, KC 1.59

Ralph Kopperman – *Some Spaces of Ideals of C^*-algebras.* WED 15:30-15:50, M 1.43

Martin Maria Kovár – *On the Weak Reflection Problem.* THU 9:25-9:45, M 1.43

Akira Koyama – *A Characterization of Compacta which Admit Acyclic UN^{n-1}-Resolutions.* THU 13:55-14:15, M 1.43

Yalçin Küçük – *Some Characterizations of Weakly-Continuous Multifunctions from a Topological Space to a Bitopological Space and of Pairwise Regularity and Pairwise Normality.* WED 15:55-16:15, M 1.43

Hans-Peter Albert Künzi – *Totally Convex Topologies.* THU 9:00-9:20, F 1.53

Arkady Leiderman – *On Linear Continuous Surjections of the Spaces $C_p(X)$.* WED 16:20-16:40, F 1.53

Dieter Leseberg – *Supernearness, Proximities and Related Extensions.* THU 14:25-14:45, M 1.29

Ronald de Man – *On Composants of Solenoids.* WED 17:40-18:00, KC 1.59

Witold Marciszewski – *A Countable X Having a Closed Subspace A with $C_p(A)$ not a Factor of $C_p(X)$.* WED 17:40-18:00, F 1.53

Pieter Maritz – *Multifunctions as Approximation Operators.* THU 9:25-9:45, F 1.53

Elena Martín-Peinador – *Nuclear Groups Respect Compactness.* WED 11:40-12:00, M 1.43

John C. Mayer – *Possible Models for Irrationally Indifferent Quadratic Julia Sets.* THU 13:30-13:50, KC 1.59

D. W. McIntyre - *Intervals in the Lattice of Topologies.* TUE 11:15-11:35, F 1.53
Michael Megrelishvili (Levy) - *Free Topological G-Groups.* THU 13:30-13:50, F 1.53
Ernest Michael - *On Certain Classes of Quotient Maps.* TUE 10:25-10:45, F 1.53
Prabudh Misra - *Monothetic Subsemigroups of Continuous Selfmaps.* TUE 17:55-18:15, M 1.29
Jacek Nikiel - *Inverse Limit Spaces; On Monotonically Normal Compact Spaces.* THU 14:50-15:10, KC 1.59
Alec Norton - *Quasiconformal Rigidity for Surface Diffeomorphisms.* WED 16:50-17:10, KC 1.59
Vladimir P. Okhezin - *When Is Non-compact Polyhedron a Lefschetz Space?.* THU 14:25-14:45, F 1.53
Arnold Oostra V. - *An Adjoint Approach to Categorical Topology.* TUE 10:50-11:10, M 1.43
Alexei V. Ostrovsky - *Minimal Class of Maps Preserving the Completeness of Polish Spaces.* THU 9:25-9:45, KC 1.37
Elliot Pearl - *Homogeneity in Powers.* THU 14:25-14:45, KC 1.37
Till Plewe - *Spatiality of Localic Products.* THU 9:50-10:10, M 1.43
Elżbieta Pol - *On Countable Unions of Finite-Dimensional Spaces.* WED 15:30-15:50, M 1.29
Harry Poppe - *On Graph Topologies for Function Spaces Generated by Connected Sets.* THU 14:50-15:10, F 1.53
Steve Purisch - *Cancellative Topological Semigroups.* TUE 17:05-17:25, KC 1.59
Mariusz Rabus - *An Initially $\aleph_1$-Compact, Countably Tight, Non-Compact Space.* WED 16:50-17:10, KC 1.37
Patrick Reardon - *Countable Perfect Sets in the Ellentuck Topology and Comparison with Euclidean and Density Topologies.* WED 17:15-17:35, M 1.43
Ellen E. Reed - *Cauchy Structures in Quasi-Uniform Spaces.* TUE 17:30-17:50, F 1.53
Dieter Remus - *Pseudocompact Refinements of Compact Group Topologies.* TUE 11:15-11:35, M 1.29
Dušan Repovš - *Cohomological Dimension Theory of Cannon-Štan'ko, Daverman and Kainian Compacta.* THU 13:30-13:50, M 1.43
E. A. Reznichenko - *Continuity in Complete Groups.* THU 13:55-14:15, KC 1.37
Desmond Robbie - *An Answer to A. D. Wallace's Question.* TUE 17:55-18:15, KC 1.59
José Rojo - *Fractality in Transfinite Dimension Topological Spaces.* THU 14:50-15:10, M 1.29
M. Rostami - *On Locally Sierpinski Spaces.* WED 17:40-18:00, M 1.43
Matatyahu Rubin - *Reconstructing Open Subsets of Banach Spaces from some Homeomorphism Groups.* WED 17:15-17:35, M 1.29
Marion Scheepers - *The Vitali Property.* WED 10:50-11:10, F 1.53
P. V. Semenov - *Some Selection Theorems for Non-Convex Valued Maps.* THU 14:50-15:10, M 1.43
Luis Miguel Villegas Silva - *Irresolvable Groups and Spaces.* TUE 10:50-11:10, M 1.29
Petr Simon - *An Honest Stiff Tree-like Algebra.* WED 17:40-18:00, KC 1.37
O. V. Sipacheva - *Quotient Maps and Weak Union Topologies in Free Topological Groups.* THU 13:30-13:50, KC 1.37
Josef Šlapal - *On a Category of Sequential Closure Spaces.* WED 16:20-16:40, M 1.43

Juris Steprāns – *Cardinal Invariants Associated with Hausdorff Dimension.*
WED 11:15-11:35, M 1.29

Franklin D. Tall – *Forcing and Normality, I.* WED 15:30-15:50, KC 1.37

Angel Tamariz-Mascarua – *Countable Product of Function Spaces Having p-Fréchet-Urysohn Like Properties.* THU 9:50-10:10, KC 1.59

P. J. Telleria – *Equivalence Between Seminormed Groups.* WED 10:25-10:45, M 1.43

Gino Tironi – *Straightenable Topological Spaces.* WED 15:55-16:15, F 1.53

Michael Tkačenko – *Induced Uniformities on Subspaces of Free Topological Groups.*
WED 10:50-11:10, M 1.43

Vladimir Tkachuk – *Two New Versions of the Point-Open Game.*
WED 10:25-10:45, F 1.53

Aaron R. Todd – *A Characterization of Oxtoby's Pseudocompleteness.*
TUE 11:40-12:00, F 1.53

Ian J. Tree – *Continuing Horrors of Topology Without Choice.* WED 15:30-15:50, F 1.53

H. Murat Tuncali – *Maps of Graphs with Hereditarily Indecomposable Limits.*
THU 13:55-14:15, KC 1.59

Reinio Vainio – *New Results on Connectedness.* THU 9:50-10:10, F 1.53

Vesko Valov – *Classical-Type Characterizations of Non-Metrizable $AE(n)$-Spaces.*
WED 11:40-12:00, F 1.53

Jerry E. Vaughan – *On $X \times Y$, Where Y is a Compact Space With Countable Tightness, and X is a Countably Compact GO-Space.*
THU 9:25-9:45, KC 1.59

Gerard A. Venema – *Local Homotopy Properties of Topological Embeddings in Codimension Two.* WED 15:55-16:15, M 1.29

J. Vermeer – *Relations Between Fixed Points of $f : X \to X$ and $\beta f : \beta X \to \beta X$.*
THU 9:50-10:10, KC 1.37

Eliza Wajch – *On $(\mathcal{D}, \mathcal{E})$-Analytic Sets.* WED 10:50-11:10, M 1.29

Stephen Watson – *Resolutions: some more Theory and its Applications to Continuum Theory, Geometric Topology and Dynamical Systems.*
THU 14:50-15:10, KC 1.37

Scott W. Williams – *Some Compact Monotonically Normal Spaces.*
THU 9:00-9:20, KC 1.37

Raymond Y. Wong – *Decomposing Homeomorphism of the Hilbert Cube.*
WED 16:50-17:10, M 1.29

Yukinobu Yajima – *Closure-Preserving Covers by Nowhere Dense Sets.*
WED 16:50-17:10, F 1.53

Tsuneyo Yamanosita – *On the Group of S^1-Equivariant Homeomorphisms of the 3-Sphere.* WED 16:20-16:40, M 1.29

Sophia Zafiridou – *Containing Planar Rational Space for the Family of Planar Rational Compacta.* THU 14:25-14:45, KC 1.59

Piotr Zakrzewski – *Extending Invariant Measures on Topological Groups.*
WED 11:15-11:35, F 1.53

Monday morning

	KC 1.37
9:15	Opening
9:30	Milnor
10:30	Break
11:00	Rudin
12:00	

Monday afternoon

Time	KC 1.37
13:30	Balcar
14:30	Break
14:55	Minicourse — Kechris
16:30	

Tuesday morning

KC 1.37

Time					
9:00	Miller				
10:00	Break				
10:25	Dow	Mauldin	Itzkowitz	Császár	Michael
10:45			Break		
10:50			Silva	Oostra V.	Charalambous
11:10	Break				
11:15	Todorčević	Becker	Remus	Brown	McIntyre
11:35			Break		
11:40			Hernández	Burdick	Todd
12:00	KC 1.37	KC 1.59	M 1.29	M 1.43	F 1.53

Tuesday afternoon

Time					
	KC 1.37				
13:30	Minicourse — Boyland				
15:05	Break				
15:30	Takens				
16:30	Break				
16:40–17:00	Juhász	Grant	Henriksen	Dontchev	Garcia-Maynez
17:00	Break				
17:05–17:25	Gruenhage	Purisch	Katrnoška	Collins	Hunsaker
17:25	Break				
17:30–17:50	Balogh	Heath	Garrido	Good	Reed
17:50	Break				
17:55–18:15		Robbie	Misra	Główczyński	Bredimas
	KC 1.37	KC 1.59	M 1.29	M 1.43	F 1.53

Wednesday morning

Time					
	KC 1.37				
9:00–10:00	R. Pol				
10:00–10:25	Break				
10:25–10:45	Dobrowolski	van Strien	Holicky	Telleria	Tkachuk
10:45–10:50			Break	Break	Break
10:50–11:10			Wajch	Tkačenko	Scheepers
11:10–11:15	Break				
11:15–11:35	Toruńczyk	Oversteegen	Steprāns	Comfort	Zakrzewski
11:35–11:40			Break	Break	Break
11:40–12:00			Kanovei	Martin-Peinador	Valov
	KC 1.37	KC 1.59	M 1.29	M 1.43	F 1.53

Wednesday afternoon

Time					
	KC 1.37				
13:30–15:05	Minicourse — Kechris				
15:05–15:30	Break				
15:30–15:50	Tall	Hagler	E. Pol	Kopperman	Tree
15:50–15:55	Break				
15:55–16:15	Junqueira	Ball	Venema	Y. Küçük	Tironi
16:15–16:20	Break				
16:20–16:40	Grunberg	Kennedy	Yamanosita	Šlapal	Leiderman
16:40–16:50	Break				
16:50–17:10	Rabus	Norton	Wong	Hansell	Yajima
17:10–17:15	Break				
17:15–17:35	Gotchev	K. Ciesielski	Rubin	Reardon	Heckmanns
17:35–17:40	Break				
17:40–18:00	Simon	De Ma[illegible]		Rostami	Marciszewski
	KC 1.37	KC 1.59	M 1.29	M 1.43	F 1.53

Thursday morning

Time	KC 1.37	KC 1.59	M 1.29	M 1.43	F 1.53
9:00–9:20	Williams	Brendle	Georgiou	Azarpanah	Künzi
9:20–9:25	Break				
9:25–9:45	Ostrovsky	Vaughan	Iliadis	Kovár	Maritz
9:45–9:50	Break				
9:50–10:10	Vermeer	Tamariz-Mascarua	Čerin	Plewe	Vainio
10:10–10:35	Break				
10:35–12:10	Minicourse — Boyland				
	KC 1.37				

Thursday afternoon

Time	KC 1.37	KC 1.59	M 1.29	M 1.43	F 1.53
13:30–13:50	Sipacheva	Mayer	Duda	Repovš	Megrelishvili
13:50–13:55	Break				
13:55–14:15	Reznichenko	Tuncali	Illanes	Koyama	De Blasi
14:15–14:25	Break				
14:25–14:45	Pearl	Zafiridou	Leseberg	Chigogidze	Okhezin
14:45–14:50	Break				
14:50–15:10	Watson	Nikiel	Rojo	Semenov	Poppe
15:10–15:35	Break				
15:35–15:55	Pelant	Gladdines	Kuperberg	Jasinski	Hung
15:55–16:00				Break	
16:00–16:20				C. Ciesielski	
16:20–16:30	Break				
16:30–17:30	Moerdijk (KC 1.37)				

ABSTRACTS

On almost P-spaces

F. Azarpanah
(Ahvaz University, Ahvaz, Iran)

A completely regular space X in which every nonempty G_δ-set has a nonempty interior, or every nonunit element of $C(X)$, the ring of real valued continuous functions on X is zerodivisor is called an almost P-space. These spaces are a natural generalization of topological P-spaces (= completely regular spaces in which every G_δ-set is open). We give some algebraic characterization of these spaces and study new properties for them. It is shown that a one-point compactification of a locally compact space X is an almost P-space if and only if X is a non-Lindelöf almost P-space. Using this we reduce some problems concerning compact almost P-spaces to locally compact ones. It is also shown that a locally compact almost P-space of cardinality less than $2^{\aleph_1}$ has an uncountable dense set of isolated points.

Room: *M 1.43* Time: *THU 9:00–9:20*

A Proper Shape Theory

V. H. Baladze

(Tbilisi State University, Tbilisi, Republic of Georgia)

In our lecture we shall give a systematic approach of (strong) proper shape theory for the category of closed pairs of locally compact paracompact spaces and proper maps. To do so we need some ideas which are developed in shape theory [1,2,3].

We introduce proper polyhedral resolutions for closed pairs of locally compact paracompact spaces and proper maps and show that any such pair and map has a proper polyhedral resolution.

Proper shape theory has many applications in topology. We studied an axiomatic characterization of proper shape theory, proper shape retracts, proper shape dimension, Whiteheads and Hurewicz theorem in proper shape theory [4], proper homology theory and so on.

A method is given for defining the (strong) proper shape theory for the category of closed pairs of Hausdorff spaces and perfect maps. Our definitions are formally similar to the one of H-shape theory [5].

References

[1] S. Mardesic, J. Segal. Shape theory, Amsterdam 1982.

[2] B. J. Ball. Alternative approaches to proper shape theory, Studies in topology, Academic Press, 1975.

[3] V. H. Baladze. Resolutions of spaces and maps and their applications in spectral homotopy theory, Doct. Diss. Tbilisi Univ., 1993, 279p.

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[5] T. J. Sanders. On the generalized and the H-shape theories, Duke Math. J. 40(1973), pp.743-754

Submitted by title.

Topology and complete Boolean algebras

Bohuslav Balcar
(Academy of Sciences of the Czech Republic, Praha, Czech Republic)

In the present lecture we shall consider a complete (σ-complete) Boolean algebra $\mathcal{B}$ as a topological space. The formula

$$\bigwedge_{k=0}^{\infty} \bigvee_{n=k}^{\infty} a_n = \bigvee_{k=0}^{\infty} \bigwedge_{n=k}^{\infty} a_n = a$$

is interpreted as "the sequence $\langle a_n \rangle$ converges to a point a" and this notion of convergence defines a sequential topology τ on $\mathcal{B}$.

We shall discuss separation properties of the topology τ and their relationship to the structural properties of the algebra $\mathcal{B}$.

Room: *KC 1.37* Time: *MON 13:30–14:30*

Projective Flows 2

Richard N. Ball
(University of Denver, Denver, CO, USA)

This category of flows has a number of attractive properties which allow familiar constructions. Recall that a continuous function $f : Y \to X$ is *perfect* if it is a closed map such that $f^{-1}(x)$ is compact for each $x \in X$.

1. All categories of flows under considerations are co-well-powered.
2. All mentioned categories have limits. In particular, they have pullbacks and inverse limits of directed systems.
3. For every perfect flow surjection $f : Y \to X$ there is an embedding $g : Z \to Y$ such that fg is T-irreducible.

Proposition. *The collection of perfect T-irreducible preimages of a given flow is upward directed in the preimage ordering: given flow surjections* $f_i : Y_i \to X$, $Y_1 \geq Y_2$ *iff there is a flow surjection* $g : Y_1 \to Y_2$ *such that* $f_2 g = f_1$.

A general construction of Banaschewski yields the existence and uniqueness of a maximal T-irreducible preimage of a given flow X. Call two flow surjections $f_i : Y_i \to X$ *equivalent* if there is an isomorphism $g : Y_1 \to Y_2$ such that $f_1 = f_2 g$.

Theorem. *For every flow X there is a flow Y and a perfect T-irreducible surjection* $f : Y \to X$ *which are unique up to equivalence with respect to the following equivalent properties.*

1. *A perfect flow surjection* $g : Z \to X$ *is T-irreducible if and only if f factors through it.*
2. *f is a perfect T-irreducible surjection, and Y has no proper perfect T-irreducible preimages.*
3. *f is a perfect T-irreducible surjection, and Y is a retract of any space which maps perfectly onto it.*
4. *f is a perfect T-irreducible surjection, and Y is a projective in the category of T-flows with perfect flow morphisms.*

We shall call the maximal T-irreducible preimage of a flow X the *projective cover* of X, and write it $\gamma_X^T : \gamma^T X \to X$. We call a flow X *projective* if $X = \gamma^T X$. We can construct $\gamma^T X$ for X compact as follows. Let $i : S \to X$ be an injection from a discrete space S onto a subspace $i(S) \subseteq X$ with the property that $Ti(S) = \{ti(s) : s \in S, t \in T\}$ is dense in X. Let τS be the free flow over S, and let $\beta^T \tau S$ be the T-Stone-Čech compactification of τS. (We will briefly outline these two constructs, which are not the subjects of this talk.) Let Y denote a subspace of $\beta^T \tau S$ given by property 3 above, let k denote the insertion of Y in $\beta^T \tau S$, and let f denote $(\beta^T \tau i)\, k$. Then the diagram contains the proof of the following theorem.

Theorem. *Y is the projective cover of X.*

Joint work by: Richard N. Ball and James N. Hagler

Room: *KC 1.59* Time: *WED 15:55–16:15*

$$\begin{tikzcd}
 & Z \arrow[d, "g"] & \\
S \arrow[ur, "j"] \arrow[r, "i"] \arrow[d, "\tau_S"'] & X & Y \arrow[ul, "h"'] \arrow[l, "f"'] \arrow[d, "k"] \\
\tau S \arrow[ur, "\tau i"'] \arrow[rr, "\beta^T_{\tau S}"'] \arrow[uur, bend left=60, "\tau j"] & & \beta^T \tau S \arrow[ul, "\beta^T \tau i"] \arrow[uul, bend right=60, "\beta^T \tau j"']
\end{tikzcd}$$

Room: *KC 1.59* Time: *WED 15:55–16:15*

A Small Dowker Space in ZFC

Zoltan T. Balogh
(Miami University, Oxford, OH, USA)

A Dowker space is a normal Hausdorff space whose product with the unit interval is not normal. In 1951 C. H. Dowker asked whether there were any such spaces. In 1971 M. E. Rudin constructed the only known example in ZFC (i.e., without extra set-theoretic hypotheses), a large space with few nice properties.

The Small Dowker Space Poblem asks whether there are smaller Dowker spaces with more nice properties such as hereditary normality. A lot of interesting answers were given in many models of set theory, but an example built from ZFC alone has been lacking until now. We prove:

Theorem. *There is a hereditarily normal, σ-relatively discrete Dowker space of cardinality $\mathfrak{c}$.*

The construction is part of an emerging new technique. Other applications and related results will be pointed out.

Room: *KC 1.37* Time: *TUE 17:30–17:50*

Solution to problem 1074

Howard Becker
(University of South Carolina, Columbia, SC, U.S.A.)

Let $\mathcal{K}(I)$ be the hyperspace of all compact subsets of the unit interval. Larman and Mauldin proved that there are $\aleph_1$ Borel measurable selectors $f_\alpha : \mathcal{K}(I) \to I$ such that if K is uncountable then the values of $f_\alpha(K)$ are distinct.

Problem 1074 in van Mill and Reed, *Open Problems in Topology*, a problem of Mauldin, is: Can one prove in ZFC that there are continuum many Borel measurable selectors on $\mathcal{K}(I)$ such that for each uncountable compact set K, the selected points of K are all distinct? The answer is no (assuming ZFC is consistent). In fact, we prove that there does not exist $\aleph_2$ Borel selectors with the above property.

Joint work by: Randall Dougherty and Howard Becker

Room: *KC 1.59* Time: *TUE 11:15–12:00*

Characteristic Radii of a Riemannian manifold

V. Boju

(University of Craiova, Craiova, Romania)

A topological disc $F \subset E^n$ defines a so called "juxtaposition function" h_F (see [1]); in particular $h_F(1)$ is just the Wadwiger number of F (see and [3]). For (M, G) a complete Riemannian manifold, $p \in M$, $r, t > 0$, let $N(p, r, t)$ be the Wadwiger number considered for metric disks on M (see [2,4]). By using $N(p, r, t)$ a characteristic function f and the sequence of characteristic radii are defined (see [2]). For instance, the corresponding values of f for characteristic radii of the standard sphere are:

$$f_0 = 0{,}405, \quad f_1 = 0{,}811, \quad f_2 = 0{,}912, \quad f_3 = 0{,}926, \quad f_4 = 0{,}949, \quad f_5 = 0{,}991.$$

Some inequalities for n and $(n-1)$-volumes and for the Laplacian's eigenvalues $L_k(M)$ are obtained in terms of characteristic radii.

References

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[3] V. Boju, L, Funar, Generalized Wadwiger numbers for symmetric ovals, Proc. Amer. Math. Soc., Vol. 119, Nr. 3, 1993, pp. 931–934.

[4] V. Boju, L. Funar, On Wadwiger numbers for Riemannian spaces, Ninth Summer Conference on General Topology and Applications, CUNY, 1993, 4 pages.

Submitted by title.

Exotic Set Theory and Topology — A short survey

A. P. Bredimas

(NCSR 'Demokritos', Athens, Greece and Université Paris 7, France)

My present talk will be concerned with 'exotic situations' beyond the usual ideas and proceedings in Toplogy, but which are closely related to well-known open and difficult problems in Set Theory and Topology and often they clarify-solve them.

In Part A, I survey the elements of the AXIOMATIC BROKEN SET THEORY, where the usual 'euclidean' CANTOR-DEDEKIND's axiom-principle *fails*. In BREDIMAS 1977–1978, I defined the a-broken line as the set $\overset{\cdot}{_a}\mathbb{R} = (-\infty, a-]\cup[a+, \infty)$ with $a- < a+$; this means that the usual real point a is the ordered-set union of the two broken real points $\{a-\}$ and $\{a+\}$. Note that all of the new-unusual results I obtained through my BROKEN FUNCTIONAL ANALYSIS are consequences of the appearance of this new extra point-set (or point-sets, in the case of many break-procedures). Also, note that broken sets of type $[b, a-]\cup\{a+\}$, which satify the 'length-preserving property', (LEBESGUE-length of $[b, a-]\cup\{a+\}$)=(LEBESGUE-length of $[b, a]$), are the most simple 'exotic sets' introducing to elementary "EXOTIC SET THEORY, GEOMETRY, TOPOLOGY, ANALYSIS, ...'

In part B, I give the necessary elements of EXOTIC TOPOLOGY THEORY related to arbitrary 'L-length-preserving exotic sets' belonging to the 'generalized collection of CARATHEODORY's prime-ends of $W \subset \mathbb{R}^2$', and I produce many examples of large classes of such 'exotic sets' arising from trigonometric series, ... etc. and corresponding to well known generalized functionals. For instance, they are defined as limiting continuous curves lying on the usual interval $[a, b]$, of LEBESGUE-integral 0, without tangents everywhere. Then, I extend this theory to 2-D exotic surfaces and produce the complete developments of the area-preserving continuous (connected) exotic surfaces generated by iterative processes from the GAUSS-LIOUVILLE surfaces which are old-LIOUVILLE's, resp. new-BREDIMAS (1979,'82,'87), explicit solutions of $\Delta f(x, y) = e^{f(x,y)}$. Then I extend this theory in arbitrary CARATHEODORY, EUCLIDE, n-dimensions and HAUSDORFF-BESICOVITCH d-dimensions ($d \in \mathbb{R}_+$), for both 'finite volume-preserving' and 'adequately infinite (classification following the power exponent, exponential, ... asymptotoic growth of the volume) volume preserving' exotic sets; explicit examples involving the related exotic extensions of the (ternary-like) CANTOR-sets, ... are given. I establish several results, as for instance: 'the generalized collection of CARATHEODORY's prime ends of a n-D connected $W \subset \mathbb{R}^n$ contains exotic sets with arbitrary HAUSDORFF-BESICOVITCH dimension $d > 0$'. Consequences are drawn in evolution-diffusion systems (generalizing the usual dynamical, hamiltonian, transport, ... ones) area, in homotopy-homology-algebraic topology-geometry (the ALEXANDER-SPANIER boundary operator is to be reconsidered in exotic frameworks), in POINCARÉ group, in lsc fuzziness, ... Finally I discuss some questions and problems that the EXOTIC SET THEORY, TOPOLOGY and analysis raise and analyse some perspectives.

Room: *F 1.53* Time: *TUE 17:55–18:15*

REFERENCES

Already published papers (CRAS, ...), series of DEMOKRITOS Internal Reports and Preprints, series of papers submitted to the ACADEMY OF ATHENS-GREECE, text of my COURS et EXERCISES at the UNIVERSITÉ PARIS 7 (1976–81,1989–94,95), my communications at ICM 78, ICM 94 and during several other conferences.

Room: *F 1.53* Time: *TUE 17:55–18:15*

Tightness in products of fans and families of functions in ω^λ

Jörg Brendle
(Mathematisches Institut, Tuebingen, Germany)

The θ-fan F_θ is the quotient space obtained by identifying the non-isolated points of the product $\theta \times (\omega + 1)$ with a single point ∞. When studying the tightness of products $F_\theta \times F_\lambda$ of fans, LaBerge and Landver [3] introduced the following notion. A subset A of the product $(\theta \times \omega) \times (\lambda \times \omega)$ is (θ, λ)-good if $(\infty, \infty) \in \bar{A}$, but $(\infty, \infty) \notin \bar{B}$ whenever either $B = A \cap ((\theta \times \omega) \times (C \times \omega))$ for some $C \in [\lambda]^{<\lambda}$ or $B = A \cap ((D \times \omega) \times (\lambda \times \omega))$ for some $D \in [\theta]^{<\theta}$. In [3] it was shown that GCH implies that there are no (θ, λ)-good sets for $\theta > \lambda$ in case $\mathrm{cf}(\lambda) \geq \omega_1$.

We can relate the existence of good sets to the existence of certain families of integer-valued functions. Given $f, g \in \omega^\lambda$, we say $f \leq^+ g$ if there is $k \in \omega$ such that for all $\alpha < \lambda$, either $f(\alpha) \leq g(\alpha)$ or $f(\alpha) \leq k$. A subset $\mathcal{F}$ of ω^λ of size θ is a (θ, λ)-*family* if $\mathcal{F}$ is $\leq^+$-unbounded, but each $\mathcal{G} \in [\mathcal{F}]^{<\theta}$ is $\leq^+$-bounded and for all $E \in [\lambda]^{<\lambda}$, $\mathcal{F} \restriction E = \{f \restriction E;\ f \in \mathcal{F}\}$ is $\leq^+$-bounded. The existence of a (θ, λ)-family implies that there is a (θ, λ)-good set; the converse holds in certain situations as well. Our main result is:

Theorem. *Assume GCH and $\lambda \leq \theta$ are cardinals with $cf(\theta) \geq \omega_1$. Then there is a ccc p.o. $\mathbb{P}$ adjoining a (θ, λ)-family (in particular, $\mathbb{P}$ adds a (θ, λ)-good set).*

Using well-known translation results [2,3], this gives (consistency-wise) new examples of first countable $< \theta$-cwH spaces which are not $\leq \theta$-cwH.

In the talk I will give a sketch of the proof of the above-mentioned Theorem as well as its connections to good sets, tightness and cwH spaces. These results will appear in joint work with T. LaBerge [1].

References

[1] J. Brendle and T. LaBerge, *Forcing tightness in products of fans*, preprint.

[2] K. Eda, G. Gruenhage, P. Koszmider, K. Tamano and S. Todorčević, *Sequential fans in topology*, preprint.

[3] T. LaBerge and A. Landver, *Tightness inproducts of fans and pseudo-fans*, preprint.

Room: *KC 1.59* Time: *THU 9:00–9:20*

A bitopological view of some cardinal functions on stably compact spaces

Lawrence M. Brown
(Hacettepe University, Ankara, Turkey)

A foundation for the study of cardinal functions on bitopological spaces has been laid down in [2] and [4]. We continue this investigation, concentrating on the class of pairwise R_1 [5] jointly compact bitopological spaces. In particular we show that for this class the biweight cannot exceed the cardinality of the space, and present an example to show that the pairwise R_1 condition is essential.

Let (X, u) be a topological space and $\mathcal{S}$ a family of subsets of X containing X and closed under finite intersections. As in [1] we may define a topology v on X by $v = \{V \mid V \subseteq X,\ x \in V \Rightarrow \exists S \in \mathcal{S},\ \mathrm{cl}_u(x) \subseteq S \subseteq \mathrm{cl}_u(S) \subseteq V\}$. Under suitable conditions on the family $\mathcal{S}$ we establish relations between the values of various cardinal functions on (X, u), (X, v) and (X, u, v). In the particular case where (X, u) is a stably compact [7] (formerly, stably locally compact [3]) space and $\mathcal{S}$ is the family of complements of saturated compact subsets of (X, u) then (X, u, v) is semi pairwise Hausdorff (i.e. pairwise R_1 and weakly pairwise T_1 [6]) and jointly compact. In particular we deduce that the weight of a stably compact space (X, u) does not exceed $|X|$, and obtain upper bounds for the value of $|X|$.

Murat Diker of Hacettepe University has collaborated in this research.

References

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Subject Classification: 54E55

Room: *M1.43* Time: *TUE 11:15–11:35*

The Asymmetric Hyperspace of a Bitopological Space

B. Burdick
(Roger Williams University, Providence, RI, USA)

We define the hyperspace of $(X, \mathcal{T}, \mathcal{T}^*)$ to be $(2^X, L(\mathcal{T}), U(\mathcal{T}^*))$ where 2^X is the set of non-empty $\mathcal{T}$-closed subsets of X, $L(\mathcal{T})$ is the lower Vietoris topology for $\mathcal{T}$, and $U(\mathcal{T}^*)$ is the upper Vietoris topology for $\mathcal{T}^*$.

Separation and compactness properties of this hyperspace are explored. We characterize which bitopological spaces are hyperspaces. Quasiproximal and quasiuniform versions of this hyperspace are also defined.

Room: M 1.43 *Time: TUE 11:40–12:00*

Approximate fibrations

Zvonko Čerin
(Zagreb, Croatia)

In this lecture we shall give a description of approximate and shape fibrations of arbitrary topological spaces using multi-valued functions. Our method is to use multi-valued functions with smaller and smaller images of points. This approach has the advantages over the inverse systems and resolutions approach to shape fibrations because it is more direct and does not require tedious search for resolutions of a given map. Several results about fibrations will be transfered to approximate fibrations of arbitrary topological spaces.

Room: *M 1.29* Time: *THU 9:50–10:10*

Direct Limits of Frames and Dimension

M. G. Charalambous
(University of the Aegean, Samos, Greece)

A frame is a complete lattice satisfying the distributive law $x \wedge \bigvee x_\lambda = \bigvee(x \wedge x_\lambda)$. A frame map is one that preserves finite meets and arbitrary joints. An example of a frame is the topology tX of a space X, and every continuous $f : X \to Y$ gives rise to a frame map $tf = f^{-1} : tY \to tX$. Direct limits of frames correspond to inverse limits of topological spaces. The category of frames, however, exhibits better properties than the category of topological spaces. Direct limits of frames preserve properties like compactness and cover regularity in conjunction with the property of being Lindelöf, paracompact or metacompact. And they do not increase the dimension of regular Lindelöf frames.

For each frame L, there is a map $j : L^* \to L$ such that L^* is regular paracompact and to each map $\phi : M \to L$ with regular paracompact domain, there corresponds a unique map $\psi : M \to L^*$ with $j\psi = \phi$. Similarly, each frame possesses a regular Lindelöf as well as a compact regular coreflection. These correspond to realcompactification and Stone-Čech compactification of topological spaces, respectively. All these coreflections preserve covering dimension. As an application, we have the formula

$$\dim(L \oplus M) \leq \dim L + \dim M$$

for regular Lindelöf frames L, M.

Room: *F 1.53* Time: *TUE 10:50–11:10*

Pseudo-boundaries and Pseudo-interiors of Menger compacta

A. Chigogidze
(University of Saskatchewan, Saskatoon, Canada)

We give characterizations of pseudo-boundaries and pseudo-interiors of k-dimensional ($k > 0$) Menger manifolds as open subspaces of the pseudo-boundary and the pseudo-interior of the universal k-dimensional Menger compactum respectively. A homotopy classification theorem for such spaces is also obtained. In particular, any $(k-1)$-connected open subspace of the universal k-dimensional Nöbeling space is homeomorphic to the whole space.

Room: *M 1.43* Time: *THU 14:25–14:45*

Topologies making a given ideal nowhere dense or meager, II

Krzysztof (Chris) Ciesielski
(West Virginia University, Morgantown, WV, USA)

Let X be a set and let $\mathcal{J}$ be an ideal on X. We investigate the question of how to find a topology τ on X such that τ-nowhere dense (or τ-meager) sets are exactly the sets in $\mathcal{J}$. The topologies will be the best possible among T_i-spaces for $i = 0, 1, 2, 3, 4$. In this talk we will concentrate on the ideals containing all singletons.

Joint work by: Krzysztof (Chris) Ciesielski and Jakub Jasinski

Room: *M 1.43* Time: *THU 16:00–16:20*

The Jordan Curve Theorem for a funnel in 2-dimensional semiflows

Krzysztof Ciesielski
(Jagiellonian University, Kraków, Poland)

Let M be a 2-dimensional connected manifold (compact or not). By a *semiflow (semidynamical system)* we mean $(M, \mathbb{R}_+, \pi)$ where $\pi : \mathbb{R}_+ \times M \to M$ is a continuous function with $\pi(0,x) = x$ and $\pi(s, \pi(t,x)) = \pi(s+t, x)$ for any $x \in M, s, t \geq 0$. A point x is said to be *stationary* if $\pi(t,x) = x$ for any $t \geq 0$, *periodic* if $\pi(t,x) = x$ for some $t > 0$ and x is not stationary, *regular* if it is neither stationary nor periodic. We put $F(t,x) = \{y \in M : \pi(t,y) = x\}$ and $F(x) = \bigcup\{F(t,x) : t \geq 0\}$, the last set is called the *funnel* through x. According to the results of McCann [*Fukc. Ekv.*, 1977] we may assume, without loss of generality, that $F(t,x)$ is compact for any $t > 0$. It is proved [Ciesielski & Omiljanowski, *Topol. Appl.*, in print] that $F(t,x)$ is a point or an arc for a nonstationary point x. A *left solution* through x is defined as a continuous function $\sigma : (-\infty, 0] \to M$ such that $\sigma(0) = x$ and $\pi(t, \sigma(s)) = \sigma(t+s)$ for $t \geq 0, s \leq 0$ with $t + s \leq 0$. By a *negative trajectory* we mean the image of a left solution. A point x is said to have *negative unicity* if $F(t,x)$ is a point for any $t \geq 0$. Roughly speaking, $F(x)$ is "the past" of a given point x, negative trajectories are "maximal possible ways" along which we may reach x.

We investigate the topological properties of the funnel $F(x)$ and negative trajectories through a non-stationary point x without negative unicity. According to the properties of $F(t,x)$ it is possible to single out two *boundary trajectories* T_1 and T_2; they are given by the solutions σ_1 and σ_2 with $\sigma_i(t)$ being the end-points of the arc $F(t,x)$. Roughly speaking, T_1 and T_2 are formed by the end-points of the arcs $F(t,x)$ for $t \geq 0$.

Set $D = F(x) \setminus (T_1 \cup T_2)$ and let T be any non-boundary trajectory through x (i.e. $T \neq T_1, T \neq T_2$). We get the following results:

(1) D is homeomorphic to $\mathbb{R}^2$

(2) T cuts D and

- (2.1) if x is regular, then $D \setminus T$ has two components, each of them homeomorphic to $\mathbb{R}^2$
- (2.2) if x is periodic, then $D \setminus T$ has two or three components, each of them homeomorphic to $\mathbb{R}^2$; the set $D \setminus T$ has three components if and only if $\pi([0,\infty) \times \{x\}) \subset T$.

Subject Classification: 54H20

Room: *KC1.59* Time: *WED 17:15–17:35*

On submaximal spaces

P. J. Collins
(Oxford University, Oxford, United Kingdom)

Definition. (Bourbaki) A space X is *submaximal* if every subset of X is open in its closure.

The paper represents a systematic study of such spaces. Sample results and questions follow.

Theorem 1. *A scattered space is submaximal if and only if it is a nodec (in the sense of van Douwen).*

Theorem 2. *Every countably compact Hausdorff nodec space is the free topological sum of finitely many Alexandroff compactifications of discrete spaces.*

Theorem 3. *Every Tychonoff pseudocompact submaximal space is scattered.*

Theorem 4. *Every separable Tychonoff submaximal space is totally disconnected.*

Theorem 5. *Every pseudolindelöf submaximal space is Lindelöf.*

Theorem 6. *Every pseudocompact nodec topological group is finite.*

Theorem 7. *Every totally bounded submaximal topological group is countable .*

Problem 1. *Is there an infinite regular connected submaximal space?*

Problem 2. *Is there in ZFC a non-discrete Hausdorff submaximal topological group?*

Joint work by: A. V. Arhangel'skii and P. J. Collins

Room: *M 1.43* Time: *TUE 17:50–17:25*

Realcompactness in the Bohr Topology

W. W. Comfort
(Wesleyan University, Middletown, CT, USA)

Throughout, the symbol G denotes a locally compact Abelian topological group, and G^+ denotes G with the topology inherited from its Bohr compactification. Given a space X we denote by $\kappa(X)$ the least number of compact sets whose union is X.

Theorem 1. *The following conditions are equivalent.* (a) *G is realcompact;* (b) *$\kappa(G)$ is not Ulam-measurable;* (c) *$\kappa(G^+)$ is not Ulam-measurable;* (d) *G^+ is realcompact;* (e) *G^+ is topologically complete.*

Theorem 2. *The following conditions are equivalent.* (a) *G^+ is hereditarily realcompact;* (b) *$\{0\}$ is a G_δ-subset of G^+;* (c) *G is metrizable and $|G| \leq \mathfrak{c}$.*

Theorem 3. *Let G be discrete Abelian and H a subgroup. Then H^+ is a topological subgroup of G^+ and H^+ is $\mathbb{R}$-embedded, $\{0,1\}$-embedded, and $\mathbb{N}$-embedded in G^+.*

Remark. Our results answer some of the questions posed by E. K. van Douwen [*Topology and Its Applications* **34** (1990), 69–91].

Joint work by: W. W. Comfort, Salvador Hernández and F. Javier Trigos-Arrieta

Room: *M 1.43* Time: *WED 11:15–11:35*

m-Proximities

Ákos Császár
(L. Eötvös University, Budapest, Hungary)

A *cover* $\underset{\sim}{c}$ of a set X is $\emptyset \neq \underset{\sim}{c} \subset \exp X$ such that $\bigcup \underset{\sim}{c} = X$; the set of all covers of X is denoted by $\underset{\sim}{C}(X)$. A *refinement* $\underset{\sim}{c}'$ of $\underset{\sim}{c} \in \underset{\sim}{C}(X)$ is $\underset{\sim}{c}' \in \underset{\sim}{C}(X)$ *such that* $C' \in \underset{\sim}{c}'$ implies $C' \subset C$ for some $C \in \underset{\sim}{c}$. For $\underset{\sim}{c}, \underset{\sim}{c}' \in \underset{\sim}{C}(X)$, $\underset{\sim}{c}(\cap)\underset{\sim}{c}' = \{C \cap C' : C \in \underset{\sim}{c}, C' \in \underset{\sim}{c}'\}$ is a common refinement. Let $\underset{\sim}{C}_f(X)$ denote the set of all finite covers of X and $\underset{\sim}{C}_m(X)$, for $2 \leq m \in \mathbb{N}$, the set of all covers $\underset{\sim}{c}$ of X with cardinality $|\underset{\sim}{c} \leq m$.

A *merotopy* $\underset{\sim}{M}$ on X is $\emptyset \neq \underset{\sim}{M} \subset \underset{\sim}{C}(X)$ such that

a) $\underset{\sim}{c} \in \underset{\sim}{M}$ whenever a refinement of c belongs to M,

b) $\underset{\sim}{c}, \underset{\sim}{c}' \in \underset{\sim}{M}$ implies $\underset{\sim}{c}(\cap)\underset{\sim}{c}' \in \underset{\sim}{M}$.

We obtain the definition of a *contiguity* on X if we substitute $\underset{\sim}{C}_f(X)$ to $\underset{\sim}{C}(X)$ in the above definition. Then it is possible to replace b) by

b') $\{C_0, C_1, \ldots, c_n\} \in \underset{\sim}{M}$, $\{C_0', C_1, \ldots, c_n\} \in \underset{\sim}{M}$ imply $\{C_0 \cap C_0', C_1, \ldots, c_n\} \in \underset{\sim}{M}$.

If we substitute $\underset{\sim}{C}_m(X)$ to $\underset{\sim}{C}(X)$ in a) and b'), we obtain the definition of a new concept, the *m-proximity*; for $m = 2$, this is the concept of a proximity (in the sense of E. Čech): let us write $A\delta B$ iff $\{X - A, X - B\} \notin \underset{\sim}{M}$.

A merotopy $\underset{\sim}{M}$ induces a contiguity ${}^f\underset{\sim}{M} = \underset{\sim}{M} \cap \underset{\sim}{C}_m(X)$. If $X_0 \subset X$ and $\underset{\sim}{M}$ is a merotopy (contiguity, m-proximity) on X, then so is $\underset{\sim}{M}/X_0 = \{\underset{\sim}{c}/X_0 : \underset{\sim}{c} \in \underset{\sim}{M}\}$ on X_0, where $\underset{\sim}{c}/X_0 = \{C \cap X_0 : C \in \underset{\sim}{c}\}$.

In the paper [1], the following problem is examined: given an m-proximity $\underset{\sim}{M}$ ($m = 2$) on X and contiguities R_i or merotopies T_i on subsets $X_i \subset X$ ($i \in I$), look for an *extension* of $\{\underset{\sim}{M}, \underset{\sim}{R}_i\}$ or $\{\underset{\sim}{M}, \underset{\sim}{T}_i\}$, i. e. a contiguity $\underset{\sim}{R}$ or a merotopy T on X such that ${}^2\underset{\sim}{R} = \underset{\sim}{M}$ and $\underset{\sim}{R}/X_i = \underset{\sim}{R}_i$ (${}^2\underset{\sim}{T} = \underset{\sim}{M}$ and $\underset{\sim}{T}/X_i = \underset{\sim}{T}_i$), $i \in I$. We intend to discuss similar problems for $m > 2$.

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Room: *M 1.43* Time: *TUE 10:25–10:45*

Topological properties of nonconvex differential inclusions

F. S. De Blasi

(Università di Roma "Tor Vergata", Rome, Italy)

Denote by $\mathbb{E}$ an m-dimensional real Euclidean space and by $\mathcal{C}(\mathbb{E})$ the space of all nonempty compact convex subsets of $\mathbb{E}$ endowed with the Hausdorff distance. For any nonempty set $Y \subset \mathbb{E}$ and $x \in \mathbb{E}$, we set $d(x,Y) = \inf\{\|x-y\| : y \in Y\}$. Moreover, we denote by $\operatorname{ext} Y$ the set of extremal points of Y.

Set $T = [a,b]$ and $X = \{x \in \mathbb{E} : d(x,U) \leq r\}$, where $U \in \mathcal{C}(\mathbb{E})$ and $r > 0$. Given a multifunction $F : T \times X \to \mathcal{C}(\mathbb{E})$, let us denote by $\mathcal{M}_{\operatorname{ext} F,U}$ the *solution set* of the Cauchy problem

$$\dot{x}(t) \in \operatorname{ext} F(t, x(t)), \qquad x(a) = u, \tag{1.1}$$

i.e. the set of all solutions $x(\cdot) : T \to \mathbb{E}$ of (1.1), with $u \in U$.

In the present paper we study some topological properties of the set $\mathcal{M}_{\operatorname{ext} F,U}$. Under the usual assumptions on F, of continuity and boundedness, the set $\mathcal{M}_{\operatorname{ext} F,U}$ is nonempty. If, in addition, F is Lipschitzean, or if F is continuous and assumes values with nonempty interior, then it is shown that the solution set $\mathcal{M}_{\operatorname{ext} F,U}$ of (1.1) is path connected, and also simply connected. It is worthwhile to observe that neither of the last two assumptions on F can be relaxed by supposing F merely continuous for, in this case, $\mathcal{M}_{\operatorname{ext} F,U}$ may fail to be path connected.

For each $u \in U$, denote by $\mathcal{T}_{\operatorname{ext} F}(u)$ the set of all solutions $x(\cdot) : T \to \mathbb{E}$ of the Cauchy problem (1.1). Then, under the above assumptions on F, it is proved that the multifunction $u \mapsto \mathcal{T}_{\operatorname{ext} F}(u)$, $u \in U$, admits a continuous selection $u \mapsto S(u)$, $u \in U$. This is no longer true, in general, if F is supposed only continuous with nonempty compact convex values.

Joint work by: F. S. De Blasi and G. Pianigiani

Room: *F 1.53* Time: *THU 13:55–14:15*

The absolute retract and fixed point properties of convex sets, examples of Cauty and Roberts and their aftermath

Tadeusz Dobrowolski
(University of Oklahoma, Norman, OK, USA)

The classical Borsuk-Dugundji and Schauder theorems assert respectively that every convex subset of a locally convex metric linear space is an absolute retract and that every convex compact subset of such a space has the fixed point property. We want to give some insight into this area when the local convexity hypothesis is dropped.

The main ingredients of our discussion are the recent discovery of a σ-compact metric linear space due to Robert Cauty, and examples of compact convex sets which *cannot be affinely embedded into a Hilbert space* elaborated by James Roberts in the mid seventies. We will point out some other properties of examples of Cauty's type and ask some questions which seem to be interesting both to topologists and analysts. A basic question would be how far the AR-property stands from local convexity; this vague question can have a few precise articulations.

Concerning the second subject, we show that Schauder's conjecture (every compact convex subset of a metric linear space has the fixed point property) is equivalent to a stronger conjecture, due to Klee, which says that a convex subset of a metric linear space has the fixed point property iff the convex set is compact. The latter is not true for nonmetric (even locally convex) spaces.

Roberts' examples, once discovered, were viewed for some time as potential counterexamples to Schauder's conjecture. Then, in the mid eighties, in the book by Kalton-Roberts-Peck, it was stated that all convex sets which can be constructed via Roberts' method have the fixed point property. However, no proof of this statement was provided therein. A proof of this fact has now been furnished. Also, it has been shown that a large class of Roberts compacta have the AR-property; though it is not clear whether all of them satisfy this property. This allows us to speculate that perhaps Schauder's conjecture holds while maybe not all convex compacta are absolute retracts (by Borsuk's theorem every compact AR-space has the fixed point property).

Room: KC 1.37 Time: *WED 10:25–11:10*

On submaximal and related spaces

Julian Dontchev
(University of Helsinki, Helsinki, Finland)

Submaximal spaces were defined by Bourbaki and hence a lot of results in General Topology involved the defined notion. In various papers submaximal spaces have been considered significantly in recent years. A topological space (X, τ) is called *submaximal* if every dense subset of X is open. In this paper submaximal spaces a characterized in details via different topological notions and various results are achieved via the simple extension of a topology over a set, which happens to be related to the notion of submaximality. Among the several concepts related to submaximality are d-compactness, $T_{\frac{1}{2}}$-separation, the door property, the MI-spaces of Hewitt (this is a property stronger than anticompactness), S- and superconnected spaces as well as hyperconnectedness and maximal connectedness. Hyperconnected spaces are also known as irreducible or D-spaces. Submaximality can be characterized via different generalized open sets, for example residual sets, preopen sets, locally closed sets, g-closed sets and $\mathcal{B}$-sets. The door property is stronger than submaximality. By definition a space X is called a *door space* if every subset of X is either open or closed. We prove that a topological space (X, τ) is a minimal door space if and only if it is hyperconnected door or τ stands for the point excluded topology by making use of a Steiner's result, which characterizes door spaces via ultraspaces. The concept of ultraspaces was introduced by Fröhlich. By definition a topology τ on a topological space X is an *ultraspace* if the only topology on X strictly finer than τ is the discrete topology. We show that minimal door spaces are precisely the connected door spaces as well as the fact that door hyperconnectedness implies anticompactness. Spaces in which compact sets are finite are called by different authors anticompact, pseudofinite or cf-spaces.

Room: *M 1.43* Time: *TUE 16:40–17:00*

Iteratively Adding reals and Topology

Alan Dow
(York University, North York, Canada)

We will discuss one or two problems in set-theoretic topology in which a countably supported interated forcing extension has been the key to the solution. The problems will likely be chosen from those concerning Fréchet-Urysohn or sequential spaces.

Room: *KC 1.37* Time: *TUE 10:25–11:10*

Products of confluent maps

Edwin Duda
(University of Miami, Coral Gables, FL, USA)

We confine these remarks to compact metric spaces even though some results easily extend to compact Hausdorff spaces and to locally compact Hausdorff spaces. The notion of a confluent mapping was initially introduced by J. J. Charatunik in 1964 [Fund. Math 56 (1964)]. A mapping $f(X) = Y$ is said to be confluent if each component K of $f^{-1}(H)$, H a continuum in Y, has $f(K) = H$. All open mappings and all monotone mappings are confluent hence the name confluent. Since the product of two open mappings is open and the product of two monotone mappings is monotone it seem natural to ask if the product of two confluent mapping is confluent. A. Lelek in 1976 [Rocky Mountain J. Math. 6(1976)] raised exactly that question. T. Maćkowiak in 1976 [Bull. Acad. Polon. Sci. Sec. Sci. Math. Astronom. Phys. 24] gave an example of a confluent map $f(X) = Y$, where X and Y are metric continua such that if h is the identity map of the unit interval $I = [0, 1]$, then $f \times h$ is not a confluent map of $X \times I$ onto $Y \times I$. We discuss the confluency of a product map in certain cases.

Room: *M 1.29* Time: *THU 13:30–13:50*

Some topological properties of Comfort types

Salvador García Ferreira
(U.N.A.M., México, D.F., Mexico)

In 1970, A. R. Bernstein introduced and studied a generalization of compactness called p-compactness, where p is a free ultrafilter on ω. This concept can be extended to every free ultrafilter on an arbitrary cardinal number. For a cardinal α, the Comfort order on $\beta(\alpha) \setminus \alpha$ is defined by $p \leq_{\mathrm{C}} q$ if every q-compact space is p-compact. Let $\leq_{\mathrm{RK}}$ denote the Rudin-Keisler order on $\beta(\alpha) \setminus \alpha$. We know that $\leq_{\mathrm{RK}} \subsetneq \leq_{\mathrm{C}}$ and $\leq_{\mathrm{RK}} \neq \leq_{\mathrm{C}}$. For $p \in \beta(\alpha) \setminus \alpha$, let $T_{\mathrm{RK}}(p) = \{q \in \beta(\alpha) \setminus \alpha : p \leq_{\mathrm{RK}} q \leq_{\mathrm{RK}} p\}$ and $T_{\mathrm{C}}(p) = \{q \in \beta(\alpha) \setminus \alpha : p \leq_{\mathrm{C}} q \leq_{\mathrm{C}} p\}$. We give some topological properties of $T_{\mathrm{C}}(p)$ and some relationships between $\leq_{\mathrm{RK}}$ and $\leq_{\mathrm{C}}$, for $p \in \beta(\alpha) \setminus \alpha$. We also state some open problems.

Submitted by title.

Special Uniformities

A. García-Máynez
(U.N.A.M., México, D.F., Mexico)

We exhibit three compatible uniformities U_μ, U_δ and U_v on a Tychonoff space X whose respective completions are $\mu X \subset \delta X \subset vX$ and such that:

1) $\mu X = vX$ iff $U_\mu = U_v$;
2) $\delta X = vX$ iff $U_\delta = U_v$;
3) $U_\mu = U_\delta$ implies $\mu X = \delta X$.

We conjecture that $\mu X = \delta X$ implies $U_\mu = U_\delta$.

The condition $U_\mu = U_\delta$ is equivalent to:

(*) For each discrete collection $\{U_i : i \in J\}$ of cozero sets and each selection of zero sets $H_i \subset U_i$ $(i \in J)$, there exists an open partition $\{L_k : k \in K\}$ of X such that for each $k \in K$, the set $\{i \in J : H_i \cap L_k \neq \Phi\}$ has non-Ulam measurable cardinality.

(*) implies that every quasi-component of X is realcompact. We prove also that every free union of realcompact spaces satisfies (*). Also, Ind $X = 0$ implies (*).

Room: *F 1.53* Time: *TUE 16:40–17:00*

Algebraic Properties of the Uniform Closure on Spaces of Continuous Functions

I. Garrido
(Univ. Extremadura, Badajoz, Spain)

For a completely regular space X, $C(X)$ denotes the algebra of all real-valued functions on X.

This paper deals with the problem of knowing when the uniform closure of certain subsets of $C(X)$ has some algebraic properties. In this context we give an internal characterization of the linear subspaces whose uniform closure is an inverse-closed subring of $C(X)$. This internal condition will be the "property A".

Joint work by: I. Garrido and F. Montalvo

Room: *M 1.29* Time: *TUE 17:30–17:50*

The property of τ-universality

D. N. Georgiou
(University of Patras, Patras, Greece)

Let Sp be a family of spaces and τ a cardinal. We say that the family Sp has the property of τ-universality iff for every subfamily $(Sp)_1 \subseteq Sp$ of cardinality $\leq \tau$, there exists an element $T \in Sp$ such that for every space $X \in (Sp)_1$ there exists an embedding of X into T.

We prove some families of separable metrizable spaces without universal elements have the property of c-universality, where c is the cardinality of the continuum.

Joint work by: D. N. Georgiou and S. D. Iliadis

Room: *M 1.29* Time: *THU 9:00–9:20*

The set of compact ANRs in the plane

Helma Gladdines
(Vrije Universiteit Amsterdam, the Netherlands)

Let $2^{[-1,1]^2}$ denote the space of all non-empty compact subsets of $[-1,1]^2$ topologised by the Vietoris topology. Let ANR denote the collection of all ANR's in $2^{[-1,1]^2}$, L the set of all locally connected sets in $2^{[-1,1]^2}$ and E the collection of sets in $2^{[-1,1]^2}$ for which the complement has only finitely many components. It is known that L is an absolute $F_{\sigma\delta}$ and E is an absolute $G_{\delta\sigma}$. It is also known that $\mathrm{ANR} = L \cap E$. The following Theorem states that ANR is in a strong sense absolute for the class of all intersections of an $F_{\sigma\delta}$ and a $G_{\delta\sigma}$ set.

Theorem. *The set* ANR *is* $(F_{\sigma\delta} \cap G_{\delta\sigma})$ *absorbing in* $2^{[-1,1]^2}$.

In particular, there is a homeomorphism of pairs

$$(2^{[-1,1]^2}, \mathrm{ANR}) \approx (Q^\infty \times Q^\infty, B^\infty \times Q^\infty \setminus B^\infty),$$

where Q denotes the Hilbert cube and B its pseudo-boundary.

Joint work by: R. Cauty, T. Dobrowolski, H. Gladdines and J. van Mill

Room: *KC1.59* Time: *THU 15:35–16:20*

Topologizing sets so that permutations are autohomeomorphisms

Christopher Good
(Oxford University, Oxford, United Kingdom)

Let X be a set and let H be a subset of the symmetric group $\mathrm{Sym}(X)$. The set of topologies $\mathcal{T}$ on X with respect to which H is a subgroup of the group of autohomeomorphisms $\mathrm{Aut}(X, \mathcal{T})$ of X forms a lattice. We discuss how the algebraic action of H on X affects the topologies in this lattice. In particular

- CH is equivalent to the statement "Every compact, first countable space equipped with an autohomeomorphism f can be re-topologized as a compact subspace of the cylinder $\{(x, y, z) : x^2+y^2 = 1, z \in [0, 1]\}$ so that f is still an autohomeomorphism."
- If κ is a regular cardinal and G is a countable subgroup of $\mathrm{Sym}(\kappa)$ then G can be realized as a subgroup of $\mathrm{Aut}(\kappa)$ iff $\left|\bigcap_{g\in G} \mathrm{fix}(g)\right| = \kappa$.
- There is a subgroup G of $\mathrm{Sym}(\mathfrak{c})$ and there are distinct topologies $\mathcal{T}_0 \subseteq \mathcal{T}_1$ such that G is a subgroup of $\mathrm{Aut}(\mathfrak{c}, \mathcal{T}_i)$ $(i \in 2)$ $\mathcal{T}_0$ is maximally compact and connected and $\mathcal{T}_1$ is minimally Hausdorff and connected.
- Let $\mathrm{HE}(\mathcal{T})$ be the lattice of topologies $\mathcal{S}$ on X which refine $\mathcal{T}$ with respect to which $\mathrm{Aut}(X, \mathcal{T})$ is a subgroup of $\mathrm{Aut}(X, \mathcal{S})$ and let $\mathrm{SYM}(X)$ be the lattice of subgroups of $\mathrm{Sym}(X)$. Bankston asks whether the map $\mathrm{Aut} : \mathrm{HE}(\mathcal{T}) \to \mathrm{SYM}(X)$ is order-preserving. We give a simple example to show that it is not.

Room: *M 1.43* Time: *TUE 17:30–17:50*

$\mathcal{P}$-closed, sequentially $\mathcal{P}$-closed and absolutely $\mathcal{P}$-closed spaces

Ivan Gotchev
(American University in Bulgaria, Blagoevgrad, Bulgaria)

Let $\mathcal{P}$ be a class of topological spaces. A $\mathcal{P}$-space X is said to be $\mathcal{P}$-closed (sequentially $\mathcal{P}$-closed [DGo],[G1]) iff X is closed (sequentially closed) in every $\mathcal{P}$-space in which it is embedded. A $\mathcal{P}$-space X is absolutely $\mathcal{P}$-closed if for every $\mathcal{P}$-space Z and for every embedding $h : X \to Z$ there exists a $\mathcal{P}$-space Y and two continuous maps $f, g : Z \to Y$ such that $h(X) = \{z \in Z | f(z) = g(z)\}$ [DG]. It is clear that if $\mathcal{P} \subset T_2$ then every absolutely $\mathcal{P}$-closed space is $\mathcal{P}$-closed.

While for $\mathcal{P} \subset T_2$ the $\mathcal{P}$-closed spaces abound and are well studied [BPS], for $\mathcal{P} \not\subset T_2$ the $\mathcal{P}$-closed spaces are quite rare. As the following results show the absolutely $\mathcal{P}$-closed spaces and sequentially $\mathcal{P}$-closed spaces can be considered as a substitute of the $\mathcal{P}$-closed spaces to certain extent.

A space X is an LM_2-space if every compact subspace of X is T_2 [H]. Obviously $T_2 \subset LM_2 \subset T_1$.

Theorem 1. ([G2]) *An LM_2-space X is LM_2-closed iff X is a compact Hausdorff space.*

An extension Y of a topological space X is called a compactly determined extension if for every point $y \in Y \setminus X$ there is $K \subset X$ such that $y \in \overline{K}^Y$ and $\overline{K}^Y$ is compact [Do].

As it was observed by D.Dikranjan and E.Giuli, the LM_2-spaces with no compactly determined LM_2-extensions coincide with the absolutely LM_2-closed spaces. On the other hand, there exists an example of an absolutely LM_2-closed space which is not compact [G2].

Let US (SUS) denote the class of all topological spaces in wh every convergent sequence has an unique limit (cluster) point. Obviously $T_2 \subset SUS \subset US \subset T_1$.

Theorem 2. ([DGo]) *Every US-closed space is finite.*

Theorem 3. ([DGo]) *The SUS-closed spaces are precisely the SUS-spaces which are finite unions of convergent sequences. In particular every SUS-closed space is compact.*

Theorem 4. ([DGo]) *An US-space is sequentially US-closed iff it is sequentially compact.*

It can be proved that every absolutely US-closed space is sequentially US-closed, so sequentially compact, but there exist examples of sequentially compact SUS-spaces which are not absolutely US-closed.[DGo]

Theorem 5. ([DGo]) *For an SUS-space X TFCAE:*

a) X is absolutely SUS-closed.
b) X is sequentially SUS-closed.
c) X is countable compact.

Room: *KC 1.37* Time: *WED 17:15–17:35*

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Room: *KC 1.37* Time: *WED 17:15–17:35*

Recent progress on the Wallace Problem

Douglass L. Grant
(University College of Cape Breton, Sydney, Canada)

The Wallace Problem asks whether every countably compact, cancellative topological semigroup is a topological group. The historical context of the problem will be reviewed, together with a discussion of recent progress toward a solution.

Subject Classification: 22

Room: *KC 1.59* Time: *TUE 16:40–17:00*

Sub-Ostaszewski Spaces

Gary Gruenhage
(Auburn University, AL, USA)

In a letter distributed last Fall via e-mail, P. J. Nyikos defined a *sub-Ostaszewski space* to be an uncountable Hausdorff space in which every closed set is either countable or co-countable. Recall that assuming axiom $\Diamond$, A. Ostaszewski constructed such a space which was also perfectly normal, countably compact, hereditarily separable, locally countable, and locally compact. Nyikos asked whether sub-Ostaszewski spaces satisfying various properties (e.g., first-countable, or regular, or ...) could be constructed from CH alone, and offered cash prizes for solutions. We answer some of these questions by constructing under CH a perfectly normal, hereditarily separable, locally countable sub-Ostaszewski space. The space is however not locally compact, first-countable, or countably compact ...; obtaining these additional properties would settle Nyikos' remaining questions.

Room: *KC 1.37* Time: *TUE 17:05–17:25*

Forcing and Normality, III

Renata Grunberg
(University of Toronto, Toronto, Canada)

Continuing the abstracts of F. D. Tall and L. R. Junqueira, we have the following results.

Theorem. *Adjoin κ Cohen reals (κ random reals), where κ is a supercompact cardinal. Over the resulting model, hereditary normality of locally compact spaces is preserved by adding any number of Cohen reals (respectively, random reals).*

Theorem. *Adjoin κ Cohen reals, where κ is any regular cardinal. Over the resulting model, normality of spaces of size and character less than $2^{\aleph_0}$ is preserved by adding fewer than κ Cohen reals.*

Room: *KC 1.37* Time: *WED 16:20–16:40*

On some points in Stone-Čech compactifications of discrete spaces

A. Gryzlov
(Udmurt State University, Izhevsk, Russia)

We consider some types of points in a remainder of βD — the Stone-Čech compactification of a discrete space of cardinality τ, like weak p-points and 0-points. We discuss properties of these points, connected with a homogeneity, a normality, cardinal invariants of the spaces.

Submitted by title.

Projective Flows 1

James N. Hagler
(University of Denver, Denver, CO, USA)

A *flow* is a pair (T, X), where T is a fixed topological monoid, X is a topological space and T acts on X in such a way that

1. $t_1(t_2x) = (t_1t_2)x$ for all $t_i \in T$, $x \in X$, and
2. the evaluation map $(t, x) \mapsto tx$ is continuous.

One often obtains information about the dynamics of a flow X by passing to a richer flow Y which is ***conjugate*** to it, i.e., one for which there is continuous surjection $f : Y \to X$ such that the following diagram commutes for each $t \in T$.

$$\begin{tikzcd} Y \arrow[r, "t"] \arrow[d, "f"'] & Y \arrow[d, "f"] \\ X \arrow[r, "t"'] & X \end{tikzcd}$$

Even after fixing a given topological monoid T of actions, one cannot hope to make meaningful statements about all the conjugates of a given flow, since they are clearly unbounded in size and complexity. Rather, one seeks to find a conjugate Y of X which is big enough to have understandable dynamics, yet small enough that meaningful conclusions about the dynamics of X can be inferred from a knowledge of the dynamics of Y. For this purpose it is natural to confine attention to *T-irreducible preimages* of X, i.e., flows Y having no closed subflows mapped onto X by f. (This is the appropriate generalization of the topological notion of irreducible map.) The natural question is whether maximal T-irreducible preimages of a given flow exist, and if so, to investigate their structure and dynamics.

In case both T and X are compact this question has a most natural answer. Let γX denote the classical projective cover (a.k.a. absolute) of a compact Hausdorff space X, considered to be a flow with trivial action. Consider T itself to be a flow with action by left multiplication, and let T act on a product of flows componentwise.

Theorem. *Let T be a compact group, and let X be a compact flow. Then the quotient X/T, obtained by identifying the points of each T-orbit, is Hausdorff. When X/T is made into a flow by endowing it with a trivial action, the quotient map is a T-irreducible surjection, and*

$$\gamma^T X = T \times \gamma(X/T).$$

Theorem. *Let T be a compact group. Then a compact flow is projective, i.e., has no proper T-irreducible preimages if and only if it is of the form $T \times Y$ for some extremally disconnected compact flow Y with trivial action.*

We show by example that, in the absence of the compactness hypothesis on T, the situation is considerably more complicated. But see part 2 (abstract by R. N. Ball).
Joint work by: Richard N. Ball and James N. Hagler

Room: *KC1.59* Time: *WED 15:30–15:50*

Some properties of general descriptive spaces

Roger W. Hansell
(University of Connecticut, Storrs, CT, USA)

Recent results will be presented dealing with several questions raised in my article *Descriptive topology*, Chapter 8 of *Recent Progress in General Topology*, M. Hušek and J. van Mill, editors, Elsevier Science Publishers, 1992. Some of the results dealing with the preservation of various descriptive spaces under perfect maps is joint work with Shiho Pan.

Room: *M 1.43* Time: *WED 16:50–17:10*

Topological semi-groups on linearly ordered topological spaces

Robert W. Heath
(University of Pittsburgh, Pittsburgh, PA, USA)

Ron Barnhart has shown that every connected, linearly ordered topological space that is a cancellative, abelian, topological semi-group can be embedded in the real line. That result, and other results of Barnhart, complements earlier work of Faucett and Mostert and Shields. Among other things it is shown here that, in the aforementioned theorem of Barnhart, the hypothesis "abelian" is unnecessary.

Room: KC 1.59 Time: *TUE 17:30–17:50*

On the topo[illegible]ltrametric spaces

U[illegible] [illegible]eckmanns
(Universität München, München, Germany)

The definition of an ultrametric space is similar to that of a non-archimedean metric space, except that the set of values is an arbitrary downward directed partially ordered set to which a least element 0 is adjoined. The main theorems are as follows.

Theorem 1. *An ultrametric space is hereditarily* N*-compact iff its cardinality is less than the first measurable cardinal.*

Theorem 2. *Assume $MA(\omega_1)$. There are no ultrametric L-spaces.*

Theorem 3. *There exists a non-separable ultrametric space which satisfies the countable chain condition. Furthermore, this space is not paracompact and, assuming (CH), not even normal.*

Room: *F 1.53* Time: *WED 17:15–17:35*

Still more on the intermediate value theorem for polynomials with coefficients in a ring of continuous functions

Melvin Henriksen
(Harvey Mudd College, Claremont, CA, USA)

Throughout, X will denote a Tychonoff space, βX its Stone-Čech compactification, and $X^* = \beta X \setminus X$, and $C(X)$ the ring of continuous real-valued functions defined on X. If $A = C(X)$, let $A[t]$ denote the ring of polynomials with coefficients in $C(X)$. If whenever $p(t) \in A[t]$ satisfies $p(u) > 0$ and $p(v) < 0$ (resp. $p(u)p(v) < 0$) for some $u, v \in A$, there must be a $w \in A$ such that $p(w) = 0$ and $u \wedge v \leq w \leq u \vee v$, the ring $C(X)$ is called an *IVT-ring* (resp. *strong IVT-ring*) and X is called an *IVT-space* (resp. a *strong IVT-space*). Recall that X is an F-space if finitely generated ideals of $C(X)$ are principal or, equivalently, if disjoint cozerosets of X are completely separated. It was shown earlier that every IVT-space is an F-space.

Theorem 1. *A compact space X is a strong IVT-space iff it is a zero-dimensional F-space.*

Theorem 2. *Every compact zero-dimensional F-space is an IVT-space.*

Theorem 3. *Each component of a compact IVT-space is a hereditarily indecomposable continuum.*

It follows that if $H = [0, \infty)$ and $1 < n < \omega$, then H^* and $(\mathbb{R}^n)^*$ are compact connected F-spaces that fail to satisfy IVT. There is an infinite compact connected F-space that is hereditarily indecomposable, but we know of no example of an infinite compact connected IVT-space—contrary to an earlier announcement that none exist.

Joint work by: Melvin Henriksen, Suzanne Larson and Jorge Martinez

Room: *M 1.29* Time: *TUE 16:40–17:00*

Ring of continuous functions on locally compact abelian groups

Salvador Hernández
(Universitat Jaume I, Castellon, Spain)

The problem we consider here is how well do the ring of all continuous functions on a locally compact Abelian group reflects topological and algebraic properties of the group. Let us suppose that G_i, $(i = 1, 2)$ is a locally compact Abelian group and $C(G_i)$ is the ring of all its complex-valued continuous functions provided with the compact open topology. If $T : C(G_1) \rightarrow C(G_2)$ is a linear separating* (or disjointness preserving) map which transforms the characters of G_1 into characters of G_2. Then the following statements hold:

(a) T is continuous and onto if and only if there exists a subgroup $H_1 \subseteq G_1$ which is topologically isomorphic to G_2.
(b) Assuming $T(C_c(G_1)) \subseteq C_c(G_2)$, then T is continuous and injective if and only if there exists a subgroup $H_2 \subseteq G_2$ such that G_1 is topologically isomorphic to G_2/H_2.
(c) H is a bijection with $H(C_c(G_1)) \subseteq C_c(G_2)$ if and only if G_1 is topologically isomorphic to G_2.

Some of these results admit a generalization to non-Abelian groups if we replace "preservation of characters" by the property of being a convolution algebra homomorphism when H is restricted to the functions with compact support.

* Separating (disjointness preserving) maps are defined by the property that whenever $f \cdot g = 0$ it follows $Hf \cdot Hg = 0$. Examples of separating maps are: ring homomorphisms, isometries (for compact spaces), bipositive linear isomorphisms, etc.

Joint work by: Salvador Hernández and Juan J. Font

Room: *M 1.29* Time: *TUE 11:40–12:00*

A large class of analytic topological spaces and descriptive topology

Petr Holický
(Charles University, Prague, Czech Republic)

There are up to now several classes of analytic topological spaces which are quite respectable. Let us point out the classical continuous images of irrationals which are separable, K-analytic spaces which are Lindelöf, Suslin subsets of complete metric spaces studied by R. W. Hansell. The attempts to use the technique of descriptive theory for, in general, not Lindelöf spaces produced several further notions of analytic spaces defined by means of upper semi-continuous compact-valued maps or complete sequences of covers all assuming some additional assumption on the map or covers ("paracompact analytic spaces" of Z. Frolík and the author, the theory of "subparacompact analytic spaces" of R. W. Hansell, J. E. Jayne and C. A. Rogers, ...).

To get a theory applicable for non-metrizable analytic topological vector spaces one needs weaker notions. This seems to be reached by Čech-analytic spaces of D. Fremlin. However, whereas we are not able to use the standard techniques of the descriptive theory of sets for Čech-analytic spaces, we are obtaining (with R. W. Hansell) a quite closed "theory" for Hansell's class of scattered-K-analytic spaces.

All Čech-analytic spaces are scattered-K-analytic. Every scattered-K-analytic space has the Baire property in any topological embedding. We can prove an analogy of Luzin's first separation principle, show some results on images of scattered-analytic spaces, on completely additive families of sets or characterize the bi-scattered-K-analytic sets. We can apply the notion to derive some geometrical property of weakly Čech-analytic Banach spaces proved originally by J. E. Jayne, C. A. Rogers and I. Namioka (even?) for weakly scattered-K-analytic Banach spaces very easily.

Room: *M 1.29* Time: *WED 10:25–10:45*

Factorization of Metrizability

H. H. Hung
(Concordia University, Montreal, Canada)

Factorizations of metrizability are many, the earliest and most famous being Bing's collectionwise normality-developability factorization. The latest is in COR. 1.2 on p. 106 Q&A9. Here we weaken, on the one hand, a σ-HPC base and restore it, on the other, to its full vigor, factoring in the process metrizability into the weakened σ-HPC base and the restorer. From our result follow at once the classical metrization results for stratifiable spaces.

Developability can be similarly treated.

Room: *F 1.53* Time: *THU 15:35–15:55*

The Nachbin Quasi-Uniformity and the Skula Topology

W. Hunsaker
(Southern Illinois University, Carbondale, IL, USA)

C.W. Neville has shown that every frame is isomorphic to the generalized Gleason algebra of an essentially unique bi-Stonian space (X, σ, τ) in which σ is a T_0 topology. Let (X, σ, τ) be as above. The specialization order $\leq_\sigma$ of (X, σ) is $\tau \times \tau$-closed. By L. Nachbin's Theorem there is exactly one quasi-uniformity $\mathcal{U}$ on X such that $\bigcap \mathcal{U} = \leq_\sigma$ and $\mathcal{T}(\mathcal{U}^*) = \tau$. This quasi-uniformity is compatible with σ and is coarser than the Pervin quasi-uniformity $\mathcal{P}$ of (X, σ). Consequently, τ is coarser than the Skula topology of σ and coincides with the Skula topology if and only if $\mathcal{U} = \mathcal{P}$.

Joint work by: P. Fletcher, J. Frith, W. Hunsaker and A. Schauerte

Room: *F 1.53* Time: *TUE 17:05–17:25*

Metrically Universal Spaces

S. D. Iliadis
(University of Patras, Patras, Greece)

Let A be a family of (metric) spaces. A space T is called (metrically) universal for the family A iff $T \in A$ and for every $X \in A$ there exists an (isometric) embedding of X into T. It is well known the result of Urysohn that in the family of all separable metric spaces there exists a metrically universal space. On the other hand there are many well-known families of separable metrizable spaces defined basically by different kinds of dimensions, for which there are universal spaces.

In [1] a general theorem about the existence of universal spaces for families of separable metrizable spaces has been proved.

Here we show that this theorem remains true if we consider metric spaces (instead of metrizable spaces) and metrically universal spaces (instead of universal spaces). From this result in particular follows that in the following families there are metrically universal spaces:

(a) countable-dimensional separable metric spaces,
(b) strongly countable-dimensional metric spaces,
(c) locally finite-dimensional separable metric spaces,
(d) spaces having small transfinite dimension less than or equal to a given countable ordinal, and
(e) separable metric spaces having D-dimension less or equal to a given countable ordinal.

References

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Room: *M1.29* Time: *THU 9:25–9:45*

Hyperspaces which are products

A. Illanes
(U.N.A.M., México D.F., Mexico)

Let X be metric continuum and let $C(X)$ be the hyperspace of subcontinua of X.
The following questions were asked by Sam B. Nadler, Jr. in 1980.

Question 1. *If $C(X)$ is a finite-dimensional product of two non-degenerate continua, then must X be an arc or a circle.*

Question 2. *If $C(X)$ is a product, then X is locally connected.*

The most general class for which he answered the first question is the class of atriodic continua. Previously, this problem has been solved for locally connected continua by *R*. Duda.

In this paper we answer affirmatively the first question and we answer the second one by showing non-locally connected continuum Z such that $C(Z) \simeq Z \times I$.

Room: *M 1.29* Time: *THU 13:55–14:15*

Iwasawa Type Decompositions

Gerald Itzkowitz
(Queens College, Flushing, NY, USA)

In his famous paper, *On some types of topological groups*, K. Iwasawa proved a number of decomposition theorems for locally compact and compact groups. Among them is his Lemma 2.4 which states that if G is a compact connected group, if N is a normal subgroup, and if $N_1 = [N, N]$ is the commutator subgroup of N, then $N = N_1 Z$ where Z is the center of N and $N_1 \cap Z$ is a totally disconnected group. We consider decompositions of compact groups G of the form $G = AN$ where A is a compact connected Abelian group and N is normal in G. Various structure theorems are proved that include the following.

Theorem 1. *Let G be a compact group and let A be a compact connected Abelian subgroup of G. If $G = AN$ where N is a compact normal subgroup of G then $G = Z(G)_0 N$, where $Z(G)_0$ is the component of the identity of the center $Z(G)$ of G.*

Theorem 2. *Let G be a compact group and A be a maximal compact connected Abelian subgroup of G. Let N be a compact normal subgroup of G such that $G = AN$. Let ϕ be an automorphism of G. Then there exists an $n \in N$ such that $n\phi(A)n^{-1} = A$.*

Theorem 3. *Let G be a compact group and let N be a closed normal subgroup of G such that G/N is connected. Then $G = Z_G(N)_0 N$, where $Z_G(N)_0$ is the component of the identity of the centralizer $Z_G(N)$ of N in G.*

Theorem 4. *Let G be a compact group and let N be a closed normal subgroup of G such that G/N is connected. Then G contains a closed normal subgroup $H \subset Z_G(N)_0$ such that*

$$G/H \simeq (Z_G(N)_0/H) \times (N/H).$$

Applications of these results are obtained. As an example we obtain:

Corollary. *Let G be a compact group such that $Z(G)$ is totally disconnected. Then the only decomposition of G of the form $G = AN$, where A is compact connected and Abelian and N is a compact normal subgroup, is the trivial one, where $N = G$.*

As a corollary we get the well-known classical folklore result that for a compact connected semi-simple Lie group G one has $G = [G, G]$.

Joint work by: Gerald Itzkowitz and Ta Sun Wu

Room: *M 1.29* Time: *TUE 10:25–10:45*

Topologies making a given ideal nowhere dense or meager, I

Jakub Jasinski
(University of Scranton, Scranton, PA, USA)

Let X be a set and let $\mathcal{J}$ be an ideal on X. We try to find the "best" possible topology τ on X such that τ-nowhere dense (or τ-meager) sets are exactly the sets in $\mathcal{J}$. In particular, we will characterize principal ideals $\mathcal{J}$ for which there exist metrizable, compact, or Hausdorff topologies τ such that τ-nowhere dense or τ-meager are sets in $\mathcal{J}$.

Joint work by: Krzysztof Ciesielski and Jakub Jasinski

Room: *M 1.43* Time: *THU 15:35–15:55*

Spaces with no smaller normal or compact topologies

I. Juhász

(Hungarian Academy of Sciences, Budapest, Hungary)

Answering some problems raised by S. Watson and S. Williams, respectively the following examples are constructed:

I. A $T_{3.5}$ space of cardinality $\mathfrak{B}$ (resp $\mathfrak{c}$) having no smaller normal (resp. pseudonormal) topology.

II. (i) If there is an S-space but no compact S-space then there is a scattered $T_{3.5}$ space of size ω_1 with no smaller countably compact T_3 topology.

(ii) If $2^{\omega_1} = \omega_2$ then there is a scattered $T_{3.5}$ space of size ω_2 and scattered height 2 with no smaller countably compact T_3 topology.

(iii) There is, in ZFC, a scattered T_3 space of size ω_3 with no smaller compact T_2 topology.

Joint work by: I. Juhász and Z. Szentmiklóssy.

Room: *KC 1.37* Time: *TUE 16:40–17:00*

Forcing and Normality, II

Lúcia R. Junqueira
(University of Toronto, Canada and University of São Paulo, Brazil)

Continuing the abstract of F. D. Tall, we have the following results:

Theorem. *Perfect normality is preserved by adding one Cohen real.*

Theorem. *Paracompactness (of T_3 spaces) is preserved by adding any number of Cohen reals. Similarly for random reals.*

Example. If there is a Lusin set, there is a locally compact, first countable normal space X such that adding one random real forces X to be not normal.

Room: *KC 1.37* Time: *WED 15:55–16:15*

On external Scott algebras in nonstandard models of Peano arithmetic

Vladimir Kanovei

(Moscow Transport Engineering Institute and Moscow State University, Moscow, Russia)

D. Scott gave in 1961 a necessary and sufficient condition for a countable set $\mathcal{Z} \subseteq \mathcal{P}(\omega)$ to be equal to the family $\mathrm{SA}(M)$ of all sets $Z \subseteq \omega$ definable in M by a parameter-free PA formula, for a model M of PA. It is evident that $\mathrm{SA}(M)$ is exactly the collection of all arithmetical $Z \subseteq \omega$ provided M is an elementary extension of ω.

One may, however, extend the PA language by the unary predicate of standardness st interpreted as being a member of ω. Let $\mathrm{ESA}(M)$, the *external Scott algebra* of M, denote the family of all subsets of ω definable in M by a parameter-free formula of the extended language.

Theorem. *Let $\mathcal{Z} \subseteq \mathcal{P}(\omega)$ be countable. Conjunction of the following two conditions is necessary and sufficient for there to exist a countable model M of PA, an elementary extension of ω, such that $\mathrm{ESA}(M) = \mathcal{Z}$.*

1. *$\mathcal{Z}$ is arithmetically closed.*
2. *$\mathcal{Z}$ contains $0^{(\omega)}$, the set of all Gödel numbers of PA sentences true in ω.*

The necessity is quite easy; the hard part is the sufficiency. A coding system is used to define a model M in which every $Z \in \mathcal{Z}$ is definable by a formula of the extended language. The main problem is to prevent any set not in $\mathcal{Z}$ from being definable in M. In particular this means that for any level n of a certain hierarchy of formulas of the extended language there should be $Z \in \mathcal{Z}$ which is not definable in M at level n (although definable in some higher level).

Room: *M 1.29* Time: *WED 11:40–12:00*

Some properties of the rings of continuous functions defined on Stonean spaces

František Katrnoška
(Institute of Chemical Technology, Prague, Czech Republic)

Let $(P, \leq, 0, 1, ')$ be an orthocomplemented poset containing a universal lower bound 0, a universal upper bound 1 and having a unary operation $' : P \to P$ so called orthocomplementation satisfying the usual requirements. The elements $p, q \in P$ are said to be non-orthogonal iff $p \not\leq q'$. M-base B [1] of P is the maximal subset of all mutually non-orthogonal elements. If we denote by $M(P)$ the set of all M-bases of an orthocomplemented poset $P = (P, \leq, 0, 1, ')$ and if we further denote (for $p \in P \setminus \{0\}$), $Z_p = \{B \in M(p), p \in B\}$, (For $p = 0$ we put $Z(0) = 0$) and if $Z(M(P)) = \{Z(p), p \in P\}$, then the following theorem of Stonean type turns out to be valid:

Theorem 1. [2,3] *Every orthocomplemented poset $P = (P, \leq, 0, 1, ')$ is orthoisomorphic to the orthocomplemented poset $(Z(M(P)), \leq, M(P), 0, ')$ of clopen subsets of 0-dimensional compact topological space $(M(P), T)$, the topology T of which is generated by $Z(M(P))$ as a subbase.*

Concerning the orthomorphisms between two orthoposets it holds:

Proposition 1. [3] *Let f be an orthomorphism of an orthocomplemented poset $(P_1, \leq, 0_1, 1_1, ')$ on the orthocomplemented poset $(P_2, \leq, 0_2, 1_2, ^*)$, the mapping $F(f) : M(P_2) \to M(P_1)$ defined by $F(f)(B) = f^{-1}(B)$, $B \in M(P_2)$ is continuous.*

Now we denote by OP a category of all orthocomplemented posets and surjective orthomorphisms and when $Comp_0$ is a category of all compact 0-dimensional topological T_2 spaces with continuous mappings, we put $F(P) = M(P)$ for each $P \in O(P)$. If $f : P_1 \to P_2$ is an orthomorphism from the orthoposet P_1 on the orthoposet P_2, then according the proposition $F(f) : M(P_2) \to M(P_1)$ is a continuous mapping and F is also a contravariant functor from the category OP to the category $Comp_0$. Now, let $(P_\tau, \leq, 0_\tau, 1_\tau, '_\tau)$, $\tau \in T$ be the system of orthoposets, and let $P = \prod_{\tau \in T} P_\tau$ be a direct product of the orthoposets $(P_\tau, \leq, 0_\tau, 1_\tau, '_\tau)$, $\tau \in T$ then each projection $h_\tau : P \to P_\tau$ induces a continuous mapping $F(h_\tau) : F(Z(M(P_\tau))) \to F(Z(M(P)))$. The mapping $F(h_\tau)$ has also some other properties. That enables to formulate the propositions which concern the sublogics and blocks of the orthoposets $(\prod_{\tau \in T} P_\tau, \leq, 0, 1, ')$. On the other hand one can establish the properties of the corresponding subspaces of $C(Z(M(P_\tau)))$, $\tau \in T$ and $C(Z(M(P)))$. (Remember, that $C(Z(M(P_\tau)))$ is the space of all continuous functions, which are defined on $Z(M(P_\tau))$, $\tau \in Y$.)

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Room: *M1.29* Time *TUE 17:05–17:25*

Generic Behavior of Homeomorphisms on Manifolds

Judy Kennedy
(University of Delaware, Newark, DE, USA)

We prove that for a large class of continua, including the compact manifolds of dimension at least 2, that most homeomorphisms, in the sense of category, admit an infinite number of attractors and repellors each of which has nonempty interior. We also discuss what can be expected for the topology of the boundaries of these attractors. (By an attractor we mean the following: If F is a homeomorphism on a continuum X, then A is an *attractor* for F if there is a proper open set U in X such that $\bigcap_{i=0}^{\infty} F^i(U) = A$ and $\overline{F(U)} \subseteq U$. A set A is a *repellor* for F if A is an attractor for F^{-1}.)

Room: *KC 1.59* Time: *WED 16:20–16:40*

Three Theorems on Weak Normality

A. P. Kombarov
(Moscow State University, Moscow, Russia)

A space X is said to be weakly normal, if for every two disjoint closed subsets A and B of X there exists a continuous mapping f of X into $\mathbb{R}^\omega$ such that $f(A) \cap f(B) = \varnothing$. This notion is a common generalization of normality and cleavability. The notion of cleavability and weak normality were introduced by A. V. Arhangel'skii.

Theorem 1. *If* $\exp(X)$ *is weakly normal and a space* X *is countably compact, then* X *is countably compact.*

Theorem 2. *If every power of a space* X *is weakly normal, then* X *is compact.*

Theorem 3. *If* $X^2 \setminus \Delta$ *is weakly normal and a space* X *is compact, then* X *is first-countable.*

Submitted by title.

Some spaces of ideals of C^*-agebras

Ralph Kopperman
(City College, CUNY, New York, NY, USA)

This talk is based on joint work with M. Henriksen, J. Mack and D. W. B. Somerset. Some years back, the latter noticed a strong similarity between many results on the space of minimal prime ideals of a commutative ring (as outlined in "A General Theory of Structure Spaces with Applications to Spaces of Prime Ideals", Alg. Univ. 28 (1991) 349-376, by the first two authors) and results that he knew on the space of minimal prime ideals of a C^*-algebra. The two theories are unified by the fact that the set of ideals of a commutative ring and the set of closed ideals of a C^*-algebra are both continuous lattices. Both this theory (developed in *A Compendium of Continuous Lattices*) and a newer theory of skew compact topological spaces are used to simplify and unify the study of these spaces of ideals.

Room: *M 1.43* Time: *WED 15:30–15:50*

On the Weak Reflection Property

Martin Maria Kovár
(Technical University of Brno, Brno, Czech Republic)

Let X be a topological space. Any compactification $\gamma(X)$ of X is said to be a *weak reflection* of X in the class of compact spaces if for every compact Y and every continuous mapping $f : X \to Y$ there exists a mapping $g : \gamma(X) \to Y$ continuously extending f. It is natural to ask whether every topological space has a weak reflection in compact spaces. This question was asked by J. Adámek and J. Rosický [AR] and was answered in the negative by M. Hušek [Hu]. Hušek also fully characterized all normal spaces which have a weak reflection in compact spaces; they are exactly the spaces with the finite Wallman (or, equivalently, Čech-Stone) remainder.

We present two main theorems. The first one states, in fact, that the assumption of normality may be omitted. In the second theorem we characterize a relatively large class of spaces which have no weak reflection in compact spaces.

Theorem A. *A topological space X has a weak reflection in compact spaces if and only if the Wallman remainder of X is finite.*

Theorem B. *Let X be a noncompact topological space which is θ-regular or T_1. If X is weakly $[\omega_1, \infty)^r$-refinable, then it has no weak reflection in compact spaces.*

Corollary. *Let X be a noncompact topological space. If X is paracompact, then it has no weak reflection in compact spaces.*

The corollary also negatively answers the question of J. Adámek and J. Rosický [AR], whether the discrete countable space has a weak reflection in compact spaces.

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Room: *M1.43* Time: *THU 9:25–9:45*

A characterization of compacta which admit acyclic UN^{n-1}-resolutions

Akira Koyama
(Osaka Kyoiku University, Osaka, Japan)

In geometric topology the existence of certain resolutions is an important problem. In cohomological dimension theory recent development is really motivated by Edwards-Walsh Theorem:

Theorem. [Edwards-Walsh Theorem] *A compactum X has $c-\dim_{\mathbb{Z}} X \leq n$ if and only if there exists a compactum Z of dimension $\leq n$ and a cell-like mapping $f : Z \to X$.*

Following their idea, Dranishnikov gave a similar resolution theorem of cohomological dimension modulo p: Considering both results, we may have expected to have a characterization of cohomological dimension with any coefficient group G by $G-$acyclic resolutions. However, there is no similar characterization of rational cohomological dimension. Hence I and Yokoi introduced the notation "*approximable dimension*, $a-\dim_G$," to obtain $G-$acyclic resolutions. It is a rather technical definition, but its place is between cohomological dimension and dimension. Moreover we otained the following characterization of compacta which admit acyclic $UV^{n-1}-$resolutions:

Theorem. *Suppose that R is a commutative ring with identity. A compactum X admits a $UV^{n-1}-$mapping from a compactum Z of dimension $\leq n$ onto X such that $\check{H}^n(f^{-1}(x); R) = 0$ for all $x \in X$ if and only if X is of $a-\dim_R X \leq n$.*

We may call f a *G-acyclic UV^{n-1}-resolution* of X. In fact, if G is finitely generated, $a-\dim_G = c-\dim_G$. Hence our result is an extension of both above theorems.

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Some characterizations of weakly-continous multifunctions from a topological space to a bitopological space and of pairwise regularity and pairwise normality

Yalçin Küçük
(Cumhuriyet Üniversitesi Fen-Edebiyat, Sivas, Turkey)

The purposes of this paper are as follows: First, we give a number of characterizations of weakly continuous multifunctions from topological spaces to bitopological spaces. We then extend weakly continuous characterizations which are known for single valued functions defined between topological spaces to weakly continuous multifunctions defined from a topological spaces to a bitopological space. Finally, we give some new characterizations of pairwise regularity and pairwise normality of bitopological spaces in terms of weakly continuous multifunctions.

Joint work by: Mahide and Yalçin Küçük

Room: *M 1.43* Time: *WED 15:55–16:15*

Totally convex topologies

Hans-Peter Albert Künzi
(University of Berne, Berne, Switzerland)

It was Pumplün who together with Röhrl started the study of the algebraic aspect of the analytic notion of a Banach space and of related concepts in a series of fundamental papers centered around the algebraic notion of a totally convex space. They also suggested to study topologies on totally convex spaces in the same way as it has been done for Banach spaces, endowing them with a Sacks space structure.

We followed their suggestions and found that hte introduction of topologies not only allowed generalizations of classical theorems, but also rendered some of the proofs and constructions in the theory of totally convex spaces more transparent.

Joint work by: Heinrich Kleisli and Hans-Peter Albert Künzi

Room: *F 1.53* Time: *THU 9:00–9:20*

Generalized counterexamples to the Seifert conjecture

Krystyna Kuperberg
(Auburn University, Auburn, AL, USA)

In 1950, H. Seifert asked whether every non-singular vector field on the 3-sphere has a closed orbit. The conjecture that the answer is yes became known as the Seifert conjecture. In 1974, P. A. Schweitzer found a C^1 counterexample to the Seifert conjecture by constructing a C^1 plug which he inserted into the irrational flow on S^3 to break the two circular orbits. J. Harrison later modified his construction to produce a C^2 counterexample.

Using a new method called self-insertion, we construct a real analytic, aperiodic plug with one minimal set from a plug with two closed orbits similar to one constructed by F. W. Wilson in 1966. The plug can be inserted into a flow on any closed 3-manifold to obtain a real analytic flow with exactly one (2-dimensional) minimal set.

Wilson showed that a manifold M of dimension ≥ 4 and Euler characteristic 0 admits a smooth vector field with no closed orbits. The above method can also be used to obtain the following (G. Kuperberg & K.K.): A foliation of any codimension of any manifold can be modified in an analytic or piecewise linear fashion so that all minimal sets have codimension 1.

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On linear continuous surjections of the spaces $C_p(X)$

Arkady Leiderman

(Ben-Gurion University of the Negev, Beer-Sheva, Israel)

The main results Theorems 1 and 2 of the paper are obtained jointly with V. Pestov and they are based on the work [1]. All topological spaces under consideration are completely regular. For every topological space X we denote by $C_p(X)$ ($C_k(X)$) the set of all real-valued continuous functions on X endowed with the topology of pointwise convergence (compact-open topology). $L(X)$ stands for the free locally convex space on X and $L_p(X)$ is the locally convex space $L(X)$ endowed with the weak topology. It is known that the weak dual space to $L(X)$ is canonically isomorphic to the space $C_p(X)$ and the spaces $L_p(X)$ and $C_p(X)$ are in duality. The space $L(X)$ admits a canonical continuous monomorphism $L(X) \hookrightarrow C_k(C_k(X))$ and provided that X is a k-space this monomorphism is an embedding of locally convex spaces.

Theorem 1. *Let X and Y be compact spaces and let $T : C_p(X) \to C_p(Y)$ be a continuous linear surjection. Then T is an open mapping.*

The proof uses the Closed Graph Theorem, Open Mapping Theorem, Michael Selection Theorem and Hann-Banach Theorem.

Recall that a topological space X is called a k_ω-space, if there exists a family $\{X_n : n \in \mathbb{N}\}$ of compact subsets of X such that $X = \bigcup_{n \in \mathbb{N}} X_n$, and every $A \subset X$ is closed in X iff $A \cap X_n$ is closed in X_n for every $n \in \mathbb{N}$.

In fact, Theorem 1 follows from the next more general statement on k_ω-spaces.

Theorem 2. *Let X and Y be k_ω-spaces. Then the following are equivalent.*

(i) $h : L_p(Y) \to L_p(X)$ is an embedding of locally convex spaces.
(ii) $h : L_p(Y) \to L_p(X)$ is a closed embedding of locally convex spaces.
(iii) $h : L(Y) \to L(X)$ is an embedding of locally convex spaces.
(iv) $h : L(Y) \to L(X)$ is a closed embedding of locally convex spaces.

Theorems 1 and 2 are not valid for the countably compact spaces. Take for example the compact space of ordinals $X = [1, \omega_1]$ and countably compact space $Y = [1, \omega_1) \subset X$. Then the usual restriction map from $C_p(X)$ to $C_p(Y)$ is a linear continuous surjection which is not open.

Proposition 1. Let X be a compact and Y be a metric space. *If $T : C_p(X) \to C_p(Y)$ is a continuous linear surjection then T is an open mapping.*

Proposition 2. *Let X be a metrizable compact space. If $T : C_p(X) \to C_p(Y)$ is a continuous linear surjection then Y is also a metrizable compact space.*

A problem of a description of the k_ω-spaces X such that the space $C_p(I)$ or $C_p(\mathbb{R})$ admits a linear continuous surjection onto the space $C_p(X)$, where $\mathbb{R}$ is the real line, $I = [0, 1]$ is the closed unit interval, was solved completely in the joint paper of the author, V. Pestov and S. Morris [1].

The proof of this result is based on the Kolmogorov Superposition Theorem.

Theorem 3. [1] *Let X be a k_ω-space. Then*

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a) *the space $C_p(X)$ is a quotient linear topological space of $C_p(I)$ if and only if X is a finite-dimensional metrizable compact space.*

b) *the space $C_p(X)$ is a quotient linear topological space of $C_p(\mathbb{R})$ if and only if every compact subspace of X is metrizable and finite-dimensional.*

Remark. The assumption that X is a k_ω-space in Theorem 3(a) may be omitted in view of Proposition 2.

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Supernearness, Proximities and Related Extensions

Dieter Leseberg
(Technical University of Braunschweig, Braunschweig, Germany)

Topologists have introduced and studied a sizeable number of topological theories and categories which include a number of corresponding classical ones as well-behaved subcategories. In 1964 Doitchinov introduced the notion of supertopological spaces in order to construct a unified theory of topological spaces, proximity spaces and uniform spaces. In 1973 Herrlich introduced nearness spaces and since that time these spaces have been used for different purposes by topologists. Some important applications of nearness spaces within topology are those of unification and extension. In 1987 Tozzi and Wyler considered generalized proximity relations over B-sets and obtained a topological category which contains both the supertopological spaces and moreover the topogenous spaces in the sense of Csaszar which are isomorphic to the quasiproximities as defined by Fletcher and Lindgren.

In 1989 nearformities are introduced by the author to get a common generalization of nearness spaces and all topological spaces and moreover this concept also contains the nonsymmetrical proximities in the sense of Leader. Additionally a one-to-one correspondence between clan-determined nearformities and topological extensions was given.

In this paper we present a common unification of all the above concepts by using the so called supernearnesses and moreover we are going to characterize those supernearness spaces which can be extended to supertopological spaces.

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On Composants of Solenoids

R. de Man
(Technische Universiteit, Delft, the Netherlands)

Solenoids were introduced by Van Dantzig in 1930. His original description runs as follows. Let $P = \{p_1, p_2, \ldots\}$ be a sequence of primes; the solenoid S_P is the intersection of a descending sequence of solid tori $T_1 \supset T_2 \supset T_3 \supset \cdots$ where T_{i+1} is wrapped around p_i times inside T_i longitudinally without folding back. In 1938 Van Heemert proved that solenoids are indecomposable continua.

In 1960 Bing conjectured that solenoids may be classified as follows: S_P and S_Q are homeomorphic if and only if the sequence P can be permuted so that it equals Q except for in a finite number of places. This conjecture was proved by McCord in 1965.

The composants of solenoids coincide with their arc components. Since solenoids are topological groups the composants of one solenoid are mutually homeomorphic. In fact much more can be said:

Theorem. *Any two composants of any two solenoids are homeomorphic.*

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A countable X having a closed subspace A with $C_p(A)$ not a factor of $C_p(X)$

Witold Marciszewski
(University of Warsaw, Warsaw, Poland)

Let A be a countable space such that the function space $C_p(A)$ is analytic. We prove that there exists a countable space X such that X contains A as a closed subset and the function space $C_p(X)$ is an absolute $F_{\sigma\delta}$-set. Therefore, if $C_p(A)$ is analytic non Borel then $C_p(A)$ is not a factor of $C_p(X)$ and there is no continuous (or even Borel-measurable) extender $e : C_p(A) \to C_p(X)$ (i.e. a map such that $e(f) \upharpoonright A = f$, for $f \in C_p(A)$). This answers a question of Arkhangel'skiĭ.

We also construct a countable space X such that the function space $C_p(X)$ is an absolute $F_{\sigma\delta}$-set and X contains closed subsets A with $C_p(A)$ of arbitrarily high Borel complexity (or even analytic non Borel).

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Multifunctions as approximation operators

P. Maritz
(University of Stellenbosch, Stellenbosch, South Africa)

In this talk we consider the concept of a rough set as defined originally by Pawlak [1], and as generalized by Pomykala [2], Wybraniec-Skardowska [3] and Żakowski [4].

The key to the approach is provided by the formulation of the standard concepts in terms of multifunctions. If F is a multifunction, then upper and lower approximations of sets in an approximation space are defined in terms of weak and strong inverses of F, respectively; the respective approximation operators will be denoted by FF^- and FF^+.

The basic topological properties of an approximation space will be mentioned. Necessary and sufficient conditons are given for FF^- and FF^+ to be topological closure and interior operators (in the sense of Kuratowski), respectively. The topologies generated by these operators will be studied.

The necessary examples, counterexamples and applications will be provided.

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Nuclear groups respect compactness

E. Martín-Peinador
(Universidad Complutense, Madrid, Spain)

Nuclear groups have been introduced by W. Banaszczyk in the monograph "Additive subgroups of topological vector spaces", Lecture Notes in Math. 1466, Springer Verlag (1991). The class of nuclear groups includes locally compact abelian topological groups, and also nuclear locally convex vector spaces. Furthermore it is closed with respect to the operations of taking subgroups, Hausdorff quotients and arbitrary products.

Following the terminology introduced by Remus and Trigos-Arrieta in [RT], we say that a topological group (G, τ) respects compactness if every weakly compact set (i.e. compact in the topology induced on G by the family of all continuous characters on G) is compact.

We have proved that nuclear groups respect compactness. Thus, the theorem of Glicksberg that LCA groups respect compactness is a direct consequence of this result. In fact they also respect pseudocompactness and functional boundedness, which in turn strengthens several results of [RT] and [T].

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Joint work by: W. Banaszczyk and E. Martín-Peinador

Room: *M 1.43* Time: *WED 11:40–12:00*

Some problems in Descriptive Set Theory

R. D. Mauldin
(North Texas University, Denton,TX, USA)

I will focus on several problems in descriptive set theory arising in topology and analysis. Some specific possibilities include the classification of continua with σ-finite Hausdorff measure with respect to some metric, Borel isomorphism classes of probability transition kernels, the complexity of the dimension kernel of n-dimensional continua, some selection problems from economics, the complexity of various geomatric measure theoretic tools, eg. packing measure.

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Possible Models for Irrationally Indifferent Quadratic Julia Sets

John C. Mayer
(University of Alabama at Birmingham, Birmingham, AL, USA)

Interesting continua arise as the Julia sets of complex analytic maps. The Julia set of a complex analytic map is the set where the dynamics is "unstable." In the quadratic family ($f_\lambda(z) = \lambda z + z^2$, for complex parameter λ), the Julia set is either a Cantor set or a one-dimensional continuum. In those cases where the Julia set is a locally-connected continuum, its topological structure is generally well-understood. At the opposite extreme, when a Julia set in the quadratic family is a continuum, but is not locally connected, as does happen for some parameter values, no topological model whatsoever is known.

For the family $f_\lambda(z) = \lambda z + z^2$, 0 is always a fixed point, attracting, repelling, or indifferent, depending upon whether $|\lambda| < 1$, $|\lambda| > 1$, or $|\lambda| = 1$, respectively. For $\lambda = e^{2\pi i\theta}$, in case θ is rational (the *parabolic* case), the indifferent fixed point 0 is in the corresponding Julia set, the Julia set is locally connected, and the structure is well-understood [Douady-Hubbard, Sullivan]. In case θ is irrational, the topological structure has not yet been fully elucidated. There are two distinct subcases:

Siegel: the indifferent fixed point 0 is in the Fatou (stable) set.
Cremer: the indifferent fixed point 0 is in the Julia set.

For Cremer points, the Julia set does not separate the plane (hence, is a tree-like continuum) and is never locally connected [Douady, Sullivan]. For Siegel points, there is a (maximal) topological disk in the Fatou set containing the indifferent fixed point on which the action of the map f_λ is analytically conjugate to a rigid rotation on the unit disk. It is not known if any Siegel Julia sets are locally connected, though it is known that some are not [Herman, Douady].

We discuss several of the open questions about the topological structure of irrationally indifferent Julia sets in the quadratic family. Then, positting plausible answers for these questions, we construct possible models for (1) the locally connected Julia set of some Siegel points and (2) the non-locally-connected Julia set of some Cremer points.

Joint work by: John C. Mayer and Lex G. Oversteegen

Room: *KC1.59* Time: *THU 13:30–13:50*

Intervals in the lattice of topologies

D. W. McIntyre
(University of Auckland, Auckland, New Zealand)

The collection of all topologies on a given set X forms a lattice T under inclusion. Given $\sigma, \tau \in T$ with $\sigma \subset \tau$ one can form the interval

$$[\sigma, \tau] = \{ \mu \in T : \sigma \subseteq \mu \subseteq \tau \}.$$

Under various assumptions about the topologies σ and τ, we investigate the following questions:

1. Is it possible for the interval $[\sigma, \tau]$ to be finite?
2. Given a finite lattice L, is it possible for the interval $[\sigma, \tau]$ to be isomorphic to L?
3. In particular, is it possible that $[\sigma, \tau] = \{\sigma, \tau\}$?

For example, we establish that if the topologies σ and τ are metrizable, then the interval $[\sigma, \tau]$ contains a copy of the power set of the natural numbers. Also, if σ and τ are both Tychonoff (resp. zero-dimensional Hausdorff) spaces and the interval $[\sigma, \tau]$ is finite, then the lattice of Tychonoff (resp. zero-dimensional Hausdorff) topologies in $[\sigma, \tau]$ must be isomorphic to the Boolean algebra 2^n for some n. In contrast, many lattices which are not of this form can be realised as intervals between two Hausdorff topologies.

Joint work by: D. W. McIntyre and S. Watson

Room: *F 1.53* Time: *TUE 11:15–11:35*

Free Topological G-Groups

Michael Megrelishvili (Levy)
(Bar-Ilan University, Ramat-Gan, Israel)

Necessary and sufficient conditions for the equivariant embeddability into: topological G-groups, G-linear spaces, homogeneous spaces, are obtained. In particular, *free topological G-groups* are investigated. A "regionally-proximal type" relation enables us to find compact homogeneous G-spaces G/H such that the free topological G-group over G/H is trivial. Using J. West's theorem about extension of actions from Z-subspaces to an action on the Hilbert cube, we prove that for every $\aleph_0$-bounded group G and a G-compactificable space X there exists an equivariant embedding of $\langle G, X\rangle$ into $\langle H(I^{\tau}), I^{\tau}\rangle$.

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On Certain Classes of Quotient Maps

Ernest Michael
(University of Washington, Seattle, WA, USA)

This will be a survey of certain classes of quotient maps, emphasizing their interrelationships and their behavior under cartesian products. Recent results on tri-quctient maps by V. V. Uspenskij and A. V. Ostrovsky will be discussed.

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Descriptive Set Theory and Forcing

Arnold W. Miller
(University of Wisconsin, Madison, WI, USA)

I plan to give a survey talk about Borel sets and descriptive set theory from the point of view of forcing. Although forcing was invented to give independence results in set theory, it has been used to prove ordinary theorems about sets of real numbers. I will touch upon many of the results proved in the last few years about Borel equivalence relations, Borel partial orders, and Borel versions of theorems of infinite combinatorics.

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Monothetic subsemigroups of continuous selfmaps

P. Misra
(College of Staten Island (CUNY), New York, NY, USA)

Some monothetic subsemigroups of the semigroup of continuous real-valued selfmaps will be discussed. Special emphasis will be given to finite monothetic semigroups.

Subject Classification: 54C05, 54C30

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Groupoids, local equivalence relations and monodromy

Ieke Moerdijk
(Rijksuniversiteit Utrecht, Utrecht, the Netherlands)

The purpose of this lecture will be to elaborate Grothendieck's suggestion concerning the leaf space of a foliation. We will give an alternative description of his invariant sheaves for a local equivalence relation, by encoding the monodromy of such sheaves in a topological groupoid. This groupoid will enable us to compare Grothendieck's approach to that of others, such as Haefliger's. We will also give a characterization of the groupoids so arising.

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Inverse limit spaces. Preliminary report

J. Nikiel
(American University of Beirut, Beirut, Lebanon)

For given compact spaces $X_1, X_2, \ldots$, the space of all inverse limits of the form

$$\lim\operatorname{inv}(X_n, f_n), \quad f_n : X_{n+1} \to X_n,$$

will be constructed and discussed together with some applications to Continuum Theory and Topological Dynamics.

Joint work by: J. Nikiel, H. M. Tuncali and E. D. Tymchatyn

Room: *KC 1.59* Time: *THU 14:50–15:10*

On monotonically normal compact spaces

J. Nikiel
(American University of Beirut, Beirut, Lebanon)

Recent results concerning internal structure of monotonically normal separable compacta will be discussed. In particular, the following theorem will be shown:

Theorem. *If* **A** *is a null-family of pairwise disjoint subsets of a separable monotonically normal compact space, then only countably many members of* **A** *can contain more than two points.*

It follows that no Filippov-type construction of perfectly normal compacta using Lusin sets can produce a separable monotonically normal compactum which is not the continuous image of the double-arrow space.

Joint work by: J. Nikiel and L. B. Treybig

Room: *KC 1.59* Time: *THU 14:50–15:10*

Quasiconformal rigidity for surface diffeomorphisms

Alec Norton
(University of Texas, Austin, TX, USA)

Denjoy's theorem on circle diffeomorphisms is a prototype of topological rigidity in one dimension: a sufficiently smooth diffeomorphism of S^1 with no periodic points must be topologically conjugate to an irrational rotation.

To what extent are there similar phenomena in two dimensions? Some results are available in the case of the 2-torus. We say that a C^1 diffeomorphism of T^2 has *Denjoy type* if it is semiconjugate to a minimal translation of T^2 such that (in analogy with the circle case) every nontrivial fiber of the semiconjugacy has interior (a wandering domain).

Theorem. (with D. Sullivan) *If f is C^{2+Z} and of Denjoy type, and f preserves a C^{1+Z} conformal structure on its minimal set, then f is quasiconformally conjugate to a translation.*

Corollary. *The minimal set of a C^3 Denjoy type diffeomorphism cannot be the complement of a union of circular disks.*

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When is non-compact polyhedron a Lefschetz space?

Vladimir P. Okhezin
(The Ural University, Yekaterinburg, Russia)

Some ideas of non-compact fixed-point theory will be presented in the talk particulary those helping to prove that a non-compact polyhedron homotopicaly equivalent to a compact polyhedron is a Lefschetz space if and only if it does not contain a closed subspace homeomorphic to the half-open interval $[0, 1)$.

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An adjoint approach to Categorical Topology

Arnold Oostra V.
(Grupo VIALTOPO, Ibague, Colombia)

A topological category can be described as a fibre-complete functor with certain order-adjoints between the fibres. This approach has proved to be very fruitful in various works done over the past years in Colombia, e.g.: representation of topological categories as functors in a standard category, description of the minimal reflexive subcategory containing a certain object, and construction of different examples.

Joint work by: Carlos Ruiz-Salguero and Arnold Oostra V.

Room: *M 1.43* Time: *TUE 10:50–11:10*

Minimal class of maps preserving the completeness of Polish spaces

A. V. Ostrovsky
(Marine Technical University, St. Petersburg, Russia)

We introduce a class of stable maps and prove the following theorem:

Theorem. *Let $f : X \to Y$ be a stable map (in particular a composition of open or closed maps) from a Polish space X onto a metrizable space Y. Then:*
(1) there is a countable set $Y_\sigma \subset Y$ and a Polish $X_0 \subset X$ such that the restriction $f|X_0$ is a perfect map onto $Y \setminus Y_\sigma$;
(2) Y is a Polish space.

A map $f : X \to Y$ is with transmission property, if for each $y \in Y$ there is a nonempty family η_y of open subsets of X not containing empty set and such that:
(a) if $U \in \eta_y$, then there is an open $O(y)$ such that $U \in \eta_{y'}$ for every $y' \in O(y)$.

Definition. A map with transmission property is said to be stable if we have in addition:
(b) if $U \in \eta_y$ and V is an open in X such that $V \supset U \cap f^{-1}(y)$, then $V \in \eta_y$.

A map $f : X \to Y$ with transmission property is said to be transquotient if we have in addition:
(c) if $U \in \eta_y$ and $\gamma = \{U_\alpha\}_{\alpha \in A}$ is a family of open in X subsets U_α such that $\bigcup_{\alpha \in A} U_\alpha \supset f^{-1}(y) \cap U$ then there is a finite number $U_{\alpha_1}, \ldots, U_{\alpha_n} \in \gamma$ and an open $O(y)$ such that $\bigcup_{i=1}^{n} U_{\alpha_i} \in \eta_{y'}$ for every $y' \in O(y) \setminus y$.

A map $f : X \to Y$ is said to be s_α-map if for every countable and compact set $S_\alpha(y)$ of order α with the summit y there is a compact $B \subset X$ such that $f(B) \subset S_\alpha(y)$ is a compact of order α with the summit y. The following conditions for a map $f : X \to Y$ between separable metric spaces X, Y are equivalent:
(i) f is a stable map;
(ii) f is an s_α-map for every $\alpha < \omega_1$;
(iii) f is a transquotient map.

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Invariant subsets of planar mappings

Lex G. Oversteegen
(University of Alabama at Birmingham, Birmingham, AL, USA)

In an attempt to understand the dynamics of planar mappings the structure of closed, invariant subsets often plays a crucial role. For example, Kerékjártó has shown that all periodic homeomorphisms of the plane are topologically conjugate to either a rotation or a reflection about a line. Similarly, the existence of certain invariant Cantor sets reveals much about the dynamics of the mapping. In particular, in those cases where the Julia set, J_c, of the polynomial map, $p_c(z) = z^2 + c$, is either a Cantor set or a locally connected continuum, the dynamics of p_c is fairly well understood. It is known that there exist parameter values, c, for which the corresponding Julia set, J_c, is not locally connected. The structure of such Julia sets remains unknown.

In this talk we will focus on invariant subsets of the plane which have a "fractal structure." These examples will be used establish the existence of mappings of the plane with interesting dynamical properties.

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Homogeneity in Powers

Elliott Pearl
(York University, North York, Canada)

G. Gruenhage asked whether X^ω is homogeneous when X is a zero-dimensional first countable regular space. Recently, Brian Lawrence proved this for subspaces of the Reals. We extend Lawrence's construction to the general case.

Joint work by: Alan Dow and Elliott Pearl

Room: *KC 1.37* Time: *THU 14:25–14:45*

Remarks on spaces of continuous functions

Jan Pelant
(Academy of Sciences of Czech Republic, Prague, Czech Republic)

I shall deal with two topics:

1) An example of a space of continuous functions on a compact space for which the vector version of the Banach-Stone theorem is valid. It was an open problem whether such a function space exists.
2) Covering properties of spaces $C_p(K)$ where K is a compact space. Counterexamples to problems of Gul′ko and Hansell will be recalled and new positive results will be stated.

These results will appear in joint papers with E. Behrends (item 1) and A. Dow and H. Junnila (item 2).

Subject Classification: 54C35, 54F15, 46E15, 46B04

Room: *KC 1.37* Time: *THU 15:35–16:20*

Spatiality of Localic Products

Till Plewe
(SUNY at Buffalo, Buffalo, NY, USA)

The subject is spatiality of localic products of topological spaces, in particular metrizable spaces. (Recall that the category of Hausdorff (or more generally sober) spaces is embedded into the category of locales. In this category products behave in many respects better than products in the category of topological spaces do. To rephrase: the subject matter is preservation of products under the embedding.) A key theorem characterizes spatiality of (localic) products of arbitrary sober spaces in terms of winning strategies in a strictly determined topological game. Some of the main applications for metrizable spaces: the product of two metrizable spaces X_1 and X_2 is nonspatial if and only if they have closed subspaces F_1 and F_2 respectively, which can be embedded into the Cantor set as dense subspaces with disjoint images. $X \times Y$ is spatial for all Y if and only if X is complete with no closed subspace homeomorphic to the irrationals. These spaces are called spatial multipliers. A space which is not strongly Baire (i.e. a space which contains a closed subspace of first category in itself) has spatial product only with spatial multipliers.

Accordingly for metrizable spaces the interesting questions lie within the strongly Baire spaces. There is a Galois connection induced by the relation 'For all $Y \in C$, $X \times_{loc} Y$ is spatial'. The poset of closed classes contains chains of order type c^+ ($c = 2^{\aleph_0}$), and subposets order-isomorphic to the powerset of c. The spaces which have spatial product with every strongly Baire metrizable space properly contain the completely metrizable spaces.

For non-metrizable spaces, it is shown that metacompact *LocComp*-scattered spaces are countable productive (because the locale products are spatial). The like results for paracompact and for Lindelöf *LocComp*-scattered spaces are known. Our method yields parallel proofs. Also countable products of completely regular *Čech*-scattered spaces are spatial, yielding analogous corollaries.

Room: *M 1.43* Time: *THU 9:50–10:10*

On countable unions of finite-dimensional spaces

Elżbieta Pol
(University of Warsaw, Warsaw, Poland)

We consider metrizable spaces. A space is called (strongly) countable-dimensional if it is the union of countably many (closed) finite-dimensional subspaces.

We discuss the well-known characterizations of countable-dimensional spaces due to J. Nagata, K. Nagami and J. H. Roberts and some recent characterizations of strongly countable-dimensional spaces and locally finite-dimensional spaces obtained by R. Engelking. We give alternative proofs of the Engelking's theorem based on Nagata's universal spaces and function space methods.

Room: *M 1.29* Time: *WED 15:30–15:50*

On some problems concerning weakly infinite-dimensional spaces

Roman Pol
(University of Warsaw, Warsaw, Poland)

A space X (we consider only separable metrizable spaces) is weakly infinite-dimensional (WID - in short) if there is no essential map of X onto the Hilbert cube.

We shall discuss several open problems concerning WID-spaces, mainly concentrating on compacta.

In particular an important open problem in this topic concerns Hurewicz-type results: if $f : X \to Y$ is a mapping between compacta and Y and the fibers of f are WID, then must X be also WID ?

Let $S_1, S_2, \ldots, S_\alpha, \ldots$, $\alpha < \omega_1$ be the Smirnov's compacta, i.e. S_j, for $j < \omega$, is the j-dimensional cube, $S_{\alpha+1}$ is the product of S_α and the interval, and for limit α, S_α is the one-point compactification of the free union of preceding Smirnov's compacta. Then every S_α has countably many components, each being a cube, and a map $f : X \to S_\alpha$ is essential if it covers essentially any of these cubes. Let $\mathcal{S}$ be the class of compacta which embed in some Smirnov's compactum.

It turns out that the problem we have stated can be reformulated in the following way: is it true that for all ordinals α from a closed unbounded set in ω_1, whenever $f : X \to Y$ is a *finite-to-one mapping*, $X, Y \in \mathcal{S}$, and X can be mapped essentially onto S_α, then some compactum in Y has an essential map onto S_α.

This is the case if, additionally, we require that the fibers of f have bounded cardinality.

Room: *KC1.37* Time: *WED 9:00–10:00*

On graph topologies for function spaces generated by connected sets

Harry Poppe
(University of Rostock, Germany)

Let X and Y be topological spaces. We denote by Y^X, $C(X,Y)$ and $G(X,Y)$ the set of all functions from X to Y, the set of all continuous functions and of all functions with closed graphs respectively. Now as is well-known, identifying a function f with its graph Γf we can transfer a (known) hyperspace topology for the product space $X \times Y$ to the function space Y^X (or to a subspace of Y^X, especially to $C(X,Y)$ or to $G(X,Y)$). A function space topology which is generated in this way we will call a graph topology. For a broad and important family of such graph topologies for each member of this family we can define an associated weaker graph topology ([1]). An interesting example of such a pair of graph topologies we get by hyperspace topologies on $X \times Y$ which are generated by connected sets.

The "weak connected" and the "connected" graph topology we compare with standard function space topologies, and we find conditions implying the joint continuity and the validity of the of the Hausdorff separation axiom for these two topologies.

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Room: *F 1.53* Time: *THU 14:50–15:10*

Cancellative Topological Semigroups

S. Purisch
(Barry University, Miami Shores, FL, USA)

We study which convergence properties at points of a cancellative toplogical semigroup X determines whether X is a topological group. This sheds some light on the Wallace problem: Is a cancellative toplogical semigroup a topological group if it is countably compact?

Joint work by: Sanju Hota, M. Rajagopalan and S. Purisch

Room: *KC 1.59* Time: *TUE 17:05–17:25*

An initially $\aleph_1$-compact, countably tight, non-compact space

Mariusz Rabus
(York University, North York, Canada)

A natural generalization of compact spaces are initially $\aleph_1$-compact spaces. Probably the simplest example of an initially $\aleph_1$-compact space which is not compact is the ordinal space ω_2. Note that this space has points of uncountable character and uncountable tightness. The lack of examples with countable tightness or first countable led to the following question asked by A. Dow and E. van Douwen: Is every initially $\aleph_1$-compact space of countable tightness (first countable) compact? They proved independently that the answer is positive under CH. Later it was proved that the answer is positive in the Cohen model (Dow), and under the PFA (Fremlin and Nyikos).

We solve the above question by constructing a consistent example of an initially $\aleph_1$-compact space of countable tightness which is not compact. Our example is not first countable, hence the question whether every first countable initially $\aleph_1$-compact space is compact remains open.

Room: *KC 1.37* Time: *WED 16:50–17:10*

The bounded-open topology and its relatives

A. B. Raha
(Indian Statistical Institute, Calcutta, India)

This paper studies Buchwalter's bounded—open topology on the set of all continuous real-valued functions on a Tychonoff space in a general setting and compares this topology with several well—known and lesser known topologies.

Subject Classification: 54C35, 54D30, 54D60, 54G10, 54G99

Submitted by title.

Countable perfect sets in the Ellentuck topology and comparison with Euclidean and Density topologies

Patrick Reardon
(S.E. Oklahoma State University, Durant, OK, USA)

The Ellentuck topology, which is a non-metrizable refinement of the Euclidean topology, is useful in characterizing a nice subclass of the Ramsey sets, namely the completely Ramsey sets, as the sets with the Baire property. This parallels work by Oxtoby which showed that in the Density topology, the Lebesgue measurable sets and the sets with the Baire property coincide. We have shown that in the Density topology, the Marczewski measurable sets can also be characterized as sets with the Baire property. Therefore a natural question arose: "In the Ellentuck topology, do the Marczewski sets have the Baire property?"

Investigation of the Ellentuck topology showed that it has the unusual property that every dense set contains a countable perfect set. Therefore it is somewhat misbehaved with respect to the Marczewski measurable sets. However, with respect to the sets with the Baire property (in both the wide and restricted sense), it behaves more like the Euclidean topology than does the Density topology.

Room: M 1.43 *Time: WED 17:15–17:35*

Cauchy structures in quasi-uniform spaces

Ellen E. Reed
(Trinity School, South Bend, IN, USA)

In the case of quasi-uniform spaces, there are several ways to define "Cauchy" filters, each of which reduces to the usual definition when the quasi-uniformity is symmetric. One way to view this situation is to recognize that with each quasi-uniformity there are several different associated Cauchy structures. In this paper we set down some axioms for such associated Cauchy structures, and identiy a minimal such structure. We are then able to construct a quasi-uniform extension in which each Cauchy structure associated with the original quasi-uniformity has a Cauchy extension. Moreover, this extension is a completion with respect to the minimal Cauchy structure.

Room: *F 1.53* Time: *TUE 17:30–17:50*

Pseudocompact Refinements of Compact Group Topologies

Dieter Remus
(Universität Hannover, Germany)

The following theorems are continuations of results contained in a joint paper with W. W. Comfort (Math. Zeitschrift 215 (1994), 337–346). Throughout this abstract, (G, τ) is a compact group of uncountable weight α, and C denotes the connected component of (G, τ).

Theorem 1. *If $cf(\alpha) > \omega$ and $w(G/C) = \alpha$, then G admits a pseudocompact group topology of weight $2^{|G|}$ which is finer than τ.*

Theorem 2. *If G/C is non-metrizable, then G admits a pseudocompact group topology which is finer than τ.*

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Cohomological Dimension Theory of Cannon-Štan'ko, Daverman and Kainian Compacta

Dušan Repovš
(University of Ljubljana, Ljubljana, Slovenia)

Cohomology theory is defined for arbitrary abelian groups. Consequently, one can define cohomological dimension, $\text{c-dim}_G X$, of a compact metric space X for any abelian group G. The standard definition of $\text{c-dim}_G X$ is via the Eilenberg-MacLane complexes $K(G,n)$.

If we consider the class $\mathcal{G}$ of nonabelian groups G, then one still has well-defined Eilenberg-MacLane complexes $K(G,1)$. Therefore it makes sense to consider the class of compact metric spaces X with cohomological dimension one for a nonabelian group $G \in \mathcal{G}$, $\text{c-dim}_G X = 1$.

The purpose of this talk is to present a joint work with *A. N. Dranišnikov* concerning the special case when the group $G \in \mathcal{G}$ is perfect. We shall also explain the connection between this topics and the 4-dimensional *Cell-like Mapping Problem*, i.e. the problem whether cell-like maps defined on a topological 4-manifold can raise dimension.

Subject Classification: 55M10

Room: *M 1.43* Time: *THU 13:30–13:50*

Continuity in Complete Groups

E. A. Reznichenko
(Moscow State University, Moscow, Russia)

A group G with a topology is *paratopological* if multiplication in G is countinuous. We say that G is *semitopological* if multiplication is separately continuous.

Theorem 1. *Let G be a paratopological group and*

(i) G is a strongly α-favorable space;
(ii) $G \times G$ is a Lindelöf space.

Then G is a topological group.

A standard example of a paratopological group which is not a topological group is the Sorgenfrey line S with the additive operation. Note that S is a Lindelöf strongly α-favorable space such that $S \times S$ is not Lindelöf.

There is the well-known Ellis Theorem [1] which can be formulated in the following way: if a semitopological Hausdorff group G is locally compact then G is a topological group. N. Brand [2] proved that any Čech-complete paratopological group is a topological group. A generalization and shorter proof of Brand's theorem can be found in [3]. H. Pfister put the question: is it true that any Čhech-complete semitopological group is a topological group? A. Bouziad proved recently [4] that a semitopological group such that is a paracompact Baire p-space is a topological group. Hence [4], a paracompact semitopological group is a topological group.

Theorem 2. *Any semitopological Čhech-complete group is a topological group.*

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Room: *KC 1.37* Time: *THU 13:55–14:15*

An answer to A.D. Wallace's question

Desmond Robbie
(University of Melbourne, Parkville, Australia)

It is shown under CH that there exists a countably compact topological semigroup with two-sided cancellation which is not a topological group. "Wallace's question" of 40 years standing is thus settled in the negative unless CH is explicitly denied. The example is a topological subsemigroup of an uncountable product of circle groups.

Joint work by: Desmond Robbie and Sergey Svetlichny

Room: *KC 1.59* Time: *TUE 17:55–18:15*

Fractality in transfinite dimension topological spaces

José Rojo
(Universidad Politécnica de Madrid, Madrid, Spain)

Some transfinite-dimensional spaces provide a good setting for the construction of infinite-dimensional spaces which are, locally, fractals. In this paper, we study some properties of "S-dim", a transfinite extension of the Lebesgue topological dimension function "dim", and we show some "locally fractal" spaces that appear naturally in this context.

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On Locally Sierpinski Spaces

M. Rostami
(Universidade da Beira Interior, Covilhã, Portugal)

A topological space is called locally Sierpinski space if every point has a neighborhood homeomorphic to a Sierpinski topological space. In this note we discuss some properties of locally Sierpinski spaces. If X is a finite set we find the number of distinct topological structures making X into a locally Sierpinski space.

Room: *M 1.43* Time: *WED 17:40–18:00*

Reconstructing open subsets of Banach spaces from some homeomorphism groups

Matatyahu Rubin
(Ben Gurion University, Israel)

We deal mainly with open subsets of Banach spaces. Regarding such sets as topological spaces, we show that they are determined by various subgroups of their homeomorphism group.

For topological spaces X and Y, $H(X,Y)$ denotes the set of homeomorphisms from X onto Y, and $H(X)$ denotes $H(X,X)$. We regard $H(X)$ as a pure group without topology. If X and Y are metric spaces, then $UC(X,Y) \stackrel{\text{def}}{=} \{h \in H(X,Y) \mid h \text{ is uniformly continuous}\}$ and $UC(X) \stackrel{\text{def}}{=} \{h \mid h, h^{-1} \in UC(X,X)\}$.

The following statement is a typical example of the results obtained in this work.

Theorem 1. *Let X and Y be arcwise convex open subsets of two Banach spaces, and suppose that φ is an isomorphism between $UC(X)$ and $UC(Y)$. then there is $\tau \in UC(X,Y)$ such that τ induces φ. Namely, for every $f \in UC(X)$, $\varphi(h) = \tau \circ h \circ \tau^{-1}$.*

We still have to define arcwise convexity. A metric space X is arcwise convex, if for every $\varepsilon > 0$ there is $\delta > 0$ such that for every $x, y \in X$: if $d(x,y) < \delta$, then there is an arc connecting x and y with diameter $< \varepsilon$.

Results like Theorem 1 are obtained for many other subgroups of $H(X)$. One such example is the group $QC(X)$ of quasiconformal homeomorphisms of X. Another example is the group of extendible homeomorphisms of an open subset of a Banach space. A homeomorphism $h \in H(X,Y)$ is extendible, if it can be extended to a continuous function from the closure of X ($\stackrel{\text{def}}{=} \text{cl}(X)$) to the closure of Y. The group $EXT(X)$ is defined to be $\{h \in H(X) \mid h \text{ and } h^{-1} \text{ are extendible}\}$. Note that in the infinite dimensional case $EXT(X)$ need not coincide with $H(\text{cl}(X))$, even if we assume that the interior of $\text{cl}(X)$ is equal to X.

The boundary of an arcwise convex open set may be rather complicated, and may contain points which are fixed under the action of $H(\text{cl}(X))$. Nevertheless, the analogue of Theorem 1 for closures of arcwise convex open sets is true.

We also prove that groups of two different types, like $UC(X)$, $EXT(Y)$, $QC(Z)$ and others are never isomorphic. (Unless of course $UC(X)$ and $EXT(X)$ coincide.)

We next comment on the intermediate steps in the proof of Theorem 1 and similar theorems. The main intermediate step is Theorem 2 below. For a metric space X, let $LIP(X)$ denote its group of bilipschitz homeomorphisms.

Theorem 2. *For $i = 1,2$ let X_i be an open subset of a Banach space E_i, and G_i be a subgroup of $H(X_i)$ containing $LIP(X_i)$. Suppose that φ is an isomorphism between G_1 and G_2. Then there is $\tau \in H(X_1, X_2)$ such that τ induces φ.*

Suppose for example, that we wish to prove that $EXT(X)$ is not isomorphic to $UC(Y)$. We argue by contradiction. If these groups are isomorphic, then by Theorem 2, there is $\tau \in H(X,Y)$ such that $(EXT(X))^{\tau} = UC(Y)$. So $(UC(X))^{\tau} \subseteq UC(Y)$. We

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prove a lemma saying that under certain assumptions on X and Y, if $\tau \in H(X,Y)$ and $(UC(X))^\tau \subseteq UC(Y)$, then τ and τ^{-1} are uniformly continuous. Hence $(UC(X))^\tau = UC(Y) = (EXT(X))^\tau$. So $UC(X) = EXT(X)$. This happens only when X is a finite dimensional bounded regular open set.

The same type of arguments are used in the other cases. Our methods apply without change to Banach manifolds.

The analogue of Theorem 1 for $\{(X, H(X)) \mid X \text{ is a Euclidean manifold}\}$ was proved by J. Whittaker in [W]. Results for many other classes of the form $\{(X, H(X)) \mid \ldots\}$ appear in Rubin [R]. W. Ling [W] proved similar theorems for many types of groups of diffeomorphisms of Euclidean manifolds possibly with extra structure. Additional cases, both finite and infinite dimensional, were proved by Rubin and Yomdin in [RY].

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A few old problems, solved and unsolved

Mary Ellen Rudin
(University of Wisconsin, Madison, WI, USA)

For an Abstract see the Title which says it all

Room: *KC 1.37* Time: *MON 11:00–12:00*

The Vitali Property

Marion Scheepers
(Boise State University, Boise, ID, USA)

We introduce a covering property, called the Vitali property, and discuss it in the context of subsets of the real line.

Room: *F 1.53* Time: *WED 10:50–11:10*

Some selection theorems for non-convex valued maps

P. V. Semenov

(Moscow State Pedagogical University, Moscow, Russia)

Definition. [3] Let $h : (0, \infty) \to [0, 2]$. The nonempty closed subset E of normed space B is said to be h-paraconvex if for any $r > 0$, for any open ball D with radius r the inequality $\mathrm{dist}(q, E) \leq h(r)r$ holds for any $q \in \mathrm{conv}(D \cap E)$.

Theorem. [3] *Let $h : (0, \infty) \to [0, 1)$ be a non-decreasing function. Then every lower semicontinuous map from a paracompact space into a Banach space with h-paraconvex values has a continuous singlevalued selection.*

For $h \equiv 0$ we obtain the E. Michael selection theorem for convex valued maps, [1]. For $h \equiv \alpha \in [0, 1)$ we obtain the E. Michael selection theorem for α-paracompact valued maps, [2].

APPLICATIONS.

A) For $n \in \mathbb{N}$ and $C > 0$ we denote by $\mathrm{Pol}(n, C) = \{ g : \mathbb{R} \to \mathbb{R} \mid g(x) = a_n x^n + \ldots + a_1 x + a_0,\ C^{-1} \leq |a_i| \leq C,\ \mathrm{Dom}(g)$ is convex and closed $\}$ and $\Gamma\,\mathrm{Pol}(n, C) = \{ E \subset \mathbb{R}^2 \mid E$ is graph of some element of $\mathrm{Pol}(n, C)$ in some orthogonal coordinate system $\}$.

Proposition 1. [4] *All elements from $\Gamma\,\mathrm{Pol}(n, C)$ are h-paraconvex subsets of $\mathbb{R}^2$ for some non-decreasing function $h : (0, \infty) \to [0, 1)$.*

For existence of selections the condition $C^{-1} \leq |a_i| \leq C$ is essential. The case of polynomials of m variabels, $m > 1$ is open question.

B) For $n \in \mathbb{N}$ and $C > 0$ we denote by $\mathrm{Lip}(n, C) = \{ g : \mathbb{R}^n \to \mathbb{R} \mid g$ is Lipschitz with constant C, $\mathrm{Dom}(g)$ is convex and closed $\}$ and $\Gamma\,\mathrm{Lip}(n, C) = \{ E \subset \mathbb{R}^{n+1} \mid E$ is graph of some element of $\mathrm{Lip}(n, C)$ in some orthogonal coordinate system $\}$.

Proposition 2. [5] *All elements from $\Gamma\,\mathrm{Lip}(n, C)$ are α-paraconvex subsets of $\mathbb{R}^{n+1}$ for some $\alpha \in [0, 1)$.*

In A) and B) the coordinate systems isn't fixed: it may be different for different values of multivalued maps.

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Room: *M1.43* Time: *THU 14:50–15:10*

Irresolvable groups and spaces

Luis Miguel Villegas Silva
(Universidad Autonoma Metropolitana Iztapalapa, Iztapalapa, Mexico)

It is proved that every uncountable Lindelöf group and every homogeneous space containing a convergent sequence are resolvable. Also, every α-bounded topological group of cardinality greater than α is resolvable. We find some conditions for a topological group topology to be irresolvable and maximal.

Subject Classification: 20K45, 54D20, 22A05, 54H11

Room: *M 1.29* Time: *TUE 10:50–11:10*

An honest stiff tree-like algebra

Petr Simon
(Universita Karlova, Praha, Czech Republic)

An atomic Boolean algebra $\mathcal{B}$ is called tree-like, if the quotient algebra $\mathcal{B}/\mathrm{At}$ is generated by a set, which is a tree under the reversed canonical order inherited from $\mathcal{B}/\mathrm{At}$ (At denotes the set of all atoms of $\mathcal{B}$). The aim of the talk is to give a ZFC example of a tree-like Boolean algebra, which is simultaneously Hopfian, dual Hopfian and almost rigid. This improves a recent result of J. Roitman, who produced a consistent example of an algebra with the same properties.

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Quotient Maps and Weak Union Topologies in Free Topological Groups

O. V. Sipacheva
(Moscow State University, Moscow, Russia)

Let X be a Tychonoff space. The free (Abelian) topological group of X in Markov's sense is denoted as $F(X)$ (as $A(X)$, respectively). We denote the set of all words in $F(X)$ $(A(X))$ consisting of at most n letters as $F_n(X)$ $(A_n(X))$. For a positive integer n the map $i_n : (X \oplus \{e\} \oplus X^{-1})^n \to F_n(X)$ $(i_n^A : (X \oplus \{0\} \oplus -X)^n \to A_n(X))$ is the natural multiplication (addition) map. A space $X = \bigcup X_n$ has the weak union topology if $U \subset X$ is open in X whenever $U \cap X_n$ is open in X_n for all n.

There are two well-known and still unsolved problems in the free topological groups theory:

1. When is the topology of $F(X) = \bigcup F_n(X)$ $(A(X) = \bigcup A_n(X))$ the weak union topology?
2. When are the maps i_n (i_n^A) quotient?

V. G. Pestov proved that i_2 is quotient iff X is strictly collectionwise normal (SCN). M. G. Tkachenko proved that if $X = \bigcup X_n$ has the weak union topology, all X_n are closed in X, X_n^k is normal and countably compact for all $n, k \in \omega$, and $X_k \subset X_n$ for $k < n$, then $F(X)$ has the weak union topology and all i_n are quotient.

K. Yamada gave a complete answer to the second question for Abelian qroups within the class of metrizable spaces.

Theorem 1. *Let X be a Tychonoff space with a continuous Mal'tsev operation such that $F(X) = \bigcup F_n(X)$ has the weak union topology and all i_n are quotient. Then X is a retract of $F(X)$.*

Corollary. *Every Mal'tsev $T_{3\frac{1}{2}}$ μ-space such that $F(X)$ is a k-space is a retract of $F(X)$.*

For every SCN space the quotient space X^2/Δ_X is Tychonoff (Δ_X is the diagonal of X^2). We denote the natural quotient map of X^2 onto X^2/Δ_X as δ_X. Theorem 2 and its corollaries have been obtained jointly with E. A. Reznichenko.

Theorem 2. *If $X \in T_{3\frac{1}{2}}$ and i_3 (i_4) is quotient then X is SCN and the map $\delta_X \times id_X : X^2 \times X \to X^2/\Delta_X \times X$ (respectively, the map $\delta_X \times \delta_X : X^2 \times X^2 \to X^2/\Delta_X \times X^2/\Delta_X$) is quotient.*

For a space X let X' be the set of all non P-points in X.

Corollary 1. *Let $X \in T_{3\frac{1}{2}}$. If i_4 is quotient then X is SCN and $\overline{X'}$ does not have uncountable closed descrete subspaces.*

Corollary 2. *Let X be a first countable $T_{3\frac{1}{2}}$ space. If i_3 is quotient X is SCN and either X is locally countably compact or X' is countably compact.*

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Theorem 3. *Let X be a countable T_2 space with the only non-isolated point p. Then $F(X) = \bigcup F_n(X)$ $(A(X) = \bigcup A_n(X))$ has the weak union topology iff for any decreasing sequence U_n of open neighborhoods of p there exists an open neighborhood U of p such that $U \setminus U_n$ is finite for all n.*

Example. There exists a countable T_2 space X with only one non-isolated point such that $F(X)$ and $A(X)$ have the weak union topologies, but X is not a k-space.

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On a category of sequential closure spaces

Josef Šlapal
(Technical University of Brno, Brno, Czech Republic)

X be a set, $\alpha > 0$ an ordinal, and $\pi : X \to \exp(X^\alpha)$ a map such that

$(x_i | i < \alpha) \in \pi(x)$ whenever $x_i = x$ for all ordinals $i < \alpha$,

$(x_i | i < \alpha) \in \pi(x) \Rightarrow$ for each ordinal j, $0 < j < \alpha$, there is a sequence $(x_i^j : i < \alpha) \in \pi(x_j)$ with $\{x_i^j : i < \alpha\} \subseteq \{x_i : i < \alpha\}$.

Then the pair (X, π) is called a *sequential* space.

For any set $A \subseteq X$ we put $u_\pi A = \{x \in X :$ there is a sequence $(x_i : i < \alpha) \in \pi(x)$ such that $x_i \in A$ for all ordinals $i < \alpha\}$. Then u_π is a closure operation on X, i.e. $u_\pi \emptyset = \emptyset$, $A \subseteq X \Rightarrow A \subseteq u_\pi A$, and $A \subseteq B \subseteq X \Rightarrow u_\pi A \subseteq u_\pi B$.

A closure space (X, u) for which there exists a sequential space (X, π) such that $u = u_\pi$ will be called a *sequential closure space*. By *Seq* we denote the category of sequential closure spaces and continuous maps. Clearly, the category *Fin* of finitely generated topological spaces and continuous maps is a (full isomorphism closed) subcategory of *Seq*. The advantage of the category *Seq* is as follows:

Theorem. *Seq has finite products and for any pair of objects $G \in Seq$, $H \in Fin$ there is an object $H^G \in Fin$ with $|H^G| = \mathrm{Mor}_{Seq}(G, H)$ such that the pair (H^G, e), where $e : G \times H^G \to H$ is the evaluation map, is a co-universal map for H with respect to the functor $G \times - : Seq \to Seq$.*

Room: *M 1.43* Time: *WED 16:20–16:40*

Cardinal invariants associated with Hausdorff dimension

Juris Steprāns
(York University, Toronto, Canada)

The cardinal invariants associated with Lebesgue measure knwon as covering number, additivity, cofinality and uniformity have been extensively studied. However, in order to attack some geometric problems related to Euclidean space and set theory, it seems to be necessary to gain some understanding of these same cardinal invariants when defined in the context of Hausdorff measures. Some progress made towards this understanding will be discussed. One of the results requires a Fubini type theorem for Hausdorff capacities which may find other applications.

Room: *M 1.29* Time: *WED 11:15–11:35*

Thin but heavy sets

Sebastian van Strien
(University of Amsterdam, Amsterdam, the Netherlands)

In topology one frequently constructs sets which are pathological. These are often thought of as not occuring in 'real life'. In this talk we shall give examples of compact sets which are nowhere dense in the complex plane and yet have positive Lebesgue measure. These sets occur as the attractors of a polynomial mapping $P(z) = z^{\ell} + c_1$. Indeed, define ω as the set of limit points of the sequence $\{P^{\circ n}(0)\}_{n \geq 0}$. This set is compact and $P(\omega) \subset \omega$. Next let $B(\omega)$ be its *basin of attraction*, i.e.,

$$B(\omega) = \{z; P^{\circ n}(z) \to \omega\}.$$

Then one has the following theorem due to Nowicki and van Strien (see Stony Brook preprint ims94-3).

Theorem. *For each sufficiently large even integer ℓ there exists a real constant c_1 such that for the corresponding polynomial P*

- *$B(\omega)$ has positive Lebesgue measure (it is heavy);*
- *the closure of $B(\omega)$ is nowhere dense (it is thin);*

In fact, the closure of $B(\omega)$ is equal to the Julia set of P.

This falsifies an old conjecture that the Julia set of a rational mapping has either zero or full Lebesgue measure. (To remind the reader: the Julia set of a rational mapping Q can be defined as the closure of the set of repelling periodic points of Q, or equivalently, as the complement of the set of points z for which there exists a neighbourhood U such that $(Q^n \restriction U)_{n \geq 0}$ forms a normal family.)

Room: *KC 1.59* Time: *WED 10:25–11:10*

Topological conjugacies, moduli, and time series

F. Takens
(Rijksuniversiteit Groningen, Groningen, the Netherlands)

We discuss some aspects of the interplay of topological, differentiable, and probabilistic structures in differentiable dynamical systems. More in particular we consider, for a continuous time dynamical system (or differential equation), attractors consisting of loops of heteroclinic orbits (a heteroclinic orbit is an orbit connecting two saddle points). Such attractors occur in a persistent way in equations used in population dynamics and also in evolution equations with certain symmetry.

It turns out that in order to give a complete classification of the *topology* of the basins of attraction of such attractors on needs invariants with values in the reals, or moduli. There are different interpretations of these moduli. One is in terms of eigenvalues of the derivative of the vector field at the saddle points (these are *differentiable invariants*). Another is in terms of the way in which time averages fail to converge (in the sense of the ergodic theorem) — this is an interpretation in *probabilistic* terms which has consequences for the time series produced by these attractors.

Room: *KC 1.37* Time: *TUE 15:30–16:30*

Forcing and Normality, I

Franklin D. Tall
(University of Toronto, Toronto, Canada)

We (R. Grunberg, L. R. Junqueira and the author) answer or partially answer several questions of S. Watson concerning the preservation of normality by forcing, and also prove some related results. These results appear in this abstract and in the abstracts of the co-authors.

Example. There is a perfectly normal space X and a countably closed partial order P which forces X to be not normal.

Example. (CH) There is a non-normal space X and a countably closed cardinal-preserving partial order P which forces X to be normal.

Theorem. *Adjoin κ Cohen reals (κ random reals), where κ is a supercompact cardinal. Over the resulting model, hereditary normality of spaces of character less than $2^{\aleph_0}$ is preserved by adding any number of Cohen reals (respectively, random reals).*

Room: *KC 1.37* Time: *WED 15:30–16:50*

Countable product of function spaces having p-Fréchet-Urysohn like properties

Angel Tamariz-Mascarua
(Universidad Nacional Autonoma de Mexico, México D.F., Mexico)

Let $\mathcal{P}$ be one of the following properties: Fréchet-Urysohn or p-Fréchet Urysohn with $p \in \omega^*$. Let $C_\pi(X)$ be the space of continuous real valued functions defined in X with the pointwise convergence topology. Let $F(X)$ be the free topological group generated by X and $L_\pi(X)$ be the dual space of $C_\pi(X)$.

In this talk we will analyze some classes of spaces X for which $\mathcal{P}$ is C_π-countable multiplicative, and we will prove that $C_\pi(X)$ has $\mathcal{P}$ iff $\prod_{n<\omega} C_\pi(X^n)$ has $\mathcal{P}$, concluding:

(i) $C_\pi(X)$ has $\mathcal{P}$ iff $C_\pi(F(X))$ has $\mathcal{P}$;

(ii) If X is a non countable locally compact metrizable space, then $C_\pi(X)$ has $\mathcal{P}$ iff $C_\pi(L_\pi(X))$ has $\mathcal{P}$.

Also we will give some results concerning P-points in ω^* related with p-Fréchet-Urysohn property and function spaces.

Room: *KC 1.59* Time: *THU 9:50–10:10*

Equivalence between seminormed groups

P. J. Telleria
(Universidad de Cantabria, Santander, Spain)

Several functional characterizations of the equivalence of seminorms on groups are given in this paper. This study allows to define a "seminorm" on the group of continuous homomorphisms between seminormed groups, extending the usual and well-known norm defined on the space of continuous linear maps between normed vector spaces.

Room: *M 1.43* Time: *WED 10:25–10:45*

Straightenable topological spaces

Gino Tironi
(University of Trieste, Trieste, Italy)

The notion of a straightenable topological space is introduced. A straightenable topological space is such that any of its subspaces is homeomorphic to a closed subset of the product of two spaces chosen in some given classes of topological spaces. In some interesting cases this notion is a generalization of cleavability. Some consequences of straightenability are proved like the following : every compact Hausdorff space which is straightenable over $\mathbb{R}^n$ has dimension not greater than n; if a compact Hausdorff space is straightenable over the class of hereditarily disconnected spaces then it is zero-dimensional. Other interesting results are: if a Lindelöf p-space is straightenable over the class of separable metrizable spaces, it is itself separable metrizable; if a locally compact Hausdorff space is straightenable over the class of the k-spaces then it is a Fréchet-Urysohn space.

Subject Classification: 54B10, 54B05, 54E35

Joint work by: Alexander V. Arhangel'skiĭ and Gino Tironi

Room: *F 1.53* Time: *WED 15:55–16:15*

Induced uniformities on subspaces of free topological groups

Michael G. Tkačenko
(Universidad Autónoma Metropolitana, Iztapalata, Mexico)

By a theorem of Graev, any continuous pseudometric d on a Tikhonov space X extends to an invariant pseudometric $\hat{d}$ on the free topological group $F(X)$. This result was applied by Pestov [1] to prove the equality ${}^*\mathcal{V}^*|_X = \mathcal{U}|_X$ for every Tikhonov space X, where ${}^*\mathcal{V}^*$ is the two-sided uniformity of $F(X)$ and $\mathcal{U}|_X$ is the universal uniformity of X. We study the uniformities on X^2 induced by ${}^*\mathcal{V}$, $\mathcal{V}^*$ and ${}^*\mathcal{V}^*$, the left, right and two-sided group uniformities of $F(X)$. To do that, X^2 is identified with a subspace of $F(X)$ under the embedding $(x, y) \mapsto x \cdot y$; $x, y \in X$. A general problem is the following one.

Problem. *What are relations between ${}^*\mathcal{V}|_{X^2}$, $\mathcal{V}^*|_{X^2}$ and ${}^*\mathcal{V}^*|_{X^2}$ on one hand and $\mathcal{U}_X \times \mathcal{U}_X$ and $\mathcal{U}_{X^2}$ on the other ($\mathcal{U}_{X^2}$ stands for the universal uniformity on X^2)?*

We show that both uniformities ${}^*\mathcal{V}|_{X^2}$ and $\mathcal{V}^*|_{X^2}$ are finer than $\mathcal{U}_X \times \mathcal{U}_X$ and prove that the equality $\mathcal{V}^*|_{X^2} = \mathcal{U}_X \times \mathcal{U}_X$ holds for every pseudocompact space X. The latter assertion is a consequence of the following theorem.

Theorem 1. *The equality ${}^*\mathcal{V}^*|_{X^2} = \mathcal{U}_X \times \mathcal{U}_X$ holds iff there exists an infinite cardinal τ such that X is pseudo-τ-compact and a P_τ-space simultaneously.*

This characterization remains valid if one replaces ${}^*\mathcal{V}^*$ by ${}^*\mathcal{V}$ or $\mathcal{V}^*$. Then we characterize the spaces satisfying the condition ${}^*\mathcal{V}|_{X^2} = \mathcal{U}_{X^2}$.

Theorem 2. *The conditions ${}^*\mathcal{V}|_{X^2} = \mathcal{U}_{X^2}$ and $\mathcal{V}^*|_{X^2} = \mathcal{U}_{X^2}$ are equivalent. Furthermore, if X is not a P-space then each of the conditions is equivalent to the requirement that the projection $p : X^2 \to X$ is functionally closed, and for a P-space X they are equivalent to the condition that for every open cover γ of X^2 there exists a disjoint open cover μ of X such that $\mu \times \mu = \{U \times V : U, V \in \mu\}$ is finer than γ.*

We also show that the equality ${}^*\mathcal{V}^*|_{X^2} = \mathcal{U}_{X^2}$ holds for each k_ω-space X and characterize metrizable spaces satisfying it:

Theorem 3. *For a metrizable space X, the following conditions are equivalent:*
(1) ${}^*\mathcal{V}|_{X^2} = \mathcal{U}_{X^2}$;
(2) X is locally compact or the set X' of all non-isolated points of X is compact.

References

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Room: *M1.43* Time: *WED 10:50–11:10*

Two new versions of the point-open game

Vladimir V. Tkachuk
(Universidad Autónoma Metropolitana, Iztapalapa, Mexico)

The point-open game was discovered independently by F. Galvin [1] and R. Telgársky [2]. Recall that it is played on a topological space X as follows: at the n-th move the first player picks a point $x_n \in X$ and the second responds with choosing an open $U_n \ni x_n$. The game stops after ω moves and the first player wins if $\bigcup\{ U_n : n \in \omega \} = X$. Otherwise the victory is ascribed to the second player.

We introduce and study the games θ and Ω. In θ the moves are made exactly as in the point-open game, but the first player wins iff $\bigcup\{ U_n : n \in \omega \}$ is dense in X. In the game Ω the first player also takes a point $x_n \in X$ at his (or her) n-th move while the second picks an open $U - n \subset X$ with $x_n \in \overline{U_n}$. The conclusion is the same as in θ, i.e. the first player wins iff $\bigcup\{ U_n : n \in \omega \}$ is dense in X.

It is clear that if the first player has a winning strategy on a space X for the game θ or Ω, then X is in some way similar to a separable space. We study such spaces X calling them θ-separable and Ω-separable respectively. It is proved that there are examples of compact spaces on which neither θ nor Ω are determined. It is established that first countable θ-separable (or Ω-separable) spaces are separable. We have also proved that

1) all dyadic spaces are θ-separable;
2) all Dugundji spaces as well as all products of separable spaces are Ω-separable;
3) Ω-separability implies the Souslin property while θ-separability doesn't.

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A Characterization of Oxtoby's Pseudocompleteness

Aaron R. Todd
(Baruch College, C.U.N.Y., New York, NY, USA)

Oxtoby's pseudocompleteness is one of several completeness conditions giving unified Baire category theorems for complete metrizable spaces, compact Hausdorff spaces and many others. Some separation is generally present, and a bitopological context provides this: $\mathbf{X} = (X, \mathcal{T}, \mathcal{T}^*)$, where $\mathcal{T}$ and $\mathcal{T}^*$ are topologies on X, is *quasiregular* if each $U \in \mathcal{T} \setminus \{\emptyset\}$ contains $\mathrm{cl}_{\mathcal{T}^*} V$, for some $V \in \mathcal{T} \setminus \{\emptyset\}$. Pseudocompleteness involves pseudobases for $\mathcal{T}$: A collection $\mathcal{B}$ of subsets of X is a *pseudobase* if (i) each $B \in \mathcal{B}$ has nonempty $\mathcal{T}$-interior and (ii) each nonempty $\mathcal{T}$-open set contains some member of $\mathcal{B}$.

We say $\mathbf{X} = (X, \mathcal{T}, \mathcal{T}^*)$ is *pseudocomplete* if it is quasiregular and there is a sequence $(\mathcal{B}_n)_n$ of pseudobases for $\mathcal{T}$ such that $\bigcap_n B_n \neq \emptyset$, whenever $B_n \in \mathcal{B}_n$ and $\mathrm{int}_{\mathcal{T}} B_n \supset \mathrm{cl}_{\mathcal{T}^*} B_{n+1}$, for $n = 1, 2, 3, \ldots$.

We may drop strong nesting:

Theorem. (Characterization Theorem) *A quasiregular bitopological space* $\mathbf{X} = (X, \mathcal{T}, \mathcal{T}^*)$ *is pseudocomplete if and only if there is a sequence* $(\mathcal{B}_n)_n$ *of pseudobases for* $\mathcal{T}$ *such that* $\bigcap_n B_n \neq \emptyset$, *whenever* $B_n \in \mathcal{B}_n$ *and* $B_n \supset B_{n+1}$ *for* $n = 1, 2, 3, \ldots$.

We call a sequence of pseudobases as in this theorem an *Oxtoby sequence*. A space with such a sequence is necessarily a Baire space (regardless of any separation). This theorem simplifies proofs involving pseudocompleteness and emphasizes the close relation between pseudocompleteness and the weakly α-favorable property of H. E. White, Jr.

[The above arises in ongoing work with M. Henriksen, R. Kopperman and M. Rayburn.]

Room: *F 1.53* Time: *TUE 11:40–12:00*

Covering properties of Aronszajn orderings

Stevo Todorčević
(University of Toronto, Toronto, Canada)

We shall try to classify Aronszajn orderings from a set-theoretical as well as a topological point of view. Some applications of this study to more traditional topological problems will also be presented.

Room: *KC1.37* Time: *TUE 11:15–12:00*

A theorem of Borsuk-Ulam type and its application to game theory

H. Toruńczyk
(Polish Academy of Sciences, Warsaw, Poland)

We'll concentrate on a result, obtained jointly with R. S. Simon and S. Spież, which in its special case can be stated as follows: If x_0 is a point of a compact set $C \subset \mathbb{R}^n$ and $f : C \to Y$ is a mapping into a space of dimension $n-1$, then in the boundary of C there exists a set C_0 mapped by f into a singleton and containing x_0 in its convex hull. We say this is a statement of Borsuk-Ulam type, as in the special case where C is a disk and Y an Euclidean space Borsuk-Ulam theorem asserts that one may take for C_0 a set consisting of 2 points. (In fact a result of Olędzki implies that C_0 may be taken to be of such a cardinality whenever Y is a manifold.) For our application however it is essential to avoid assuming any local properties of Y and also to allow f to be a multifunction. The application aluded to above consist of solving in the positive a problem in game theory concerning the existence of equlibria in certain games of incomplete information on one side. A geometric counterpart of the game-theorethic result provides conditions on convex sets $P, Q \subset \mathbb{R}^n$ and on a family $\{b_v : Q \to \mathbb{R}\}_{v \in \mathbb{R}^n}$ of convex functions which suffice that the following be true: given a $p_0 \in P$ and a function $a : Q \to \mathbb{R}$ such that $a \leq b_v$, $\forall v \in \mathbb{R}^n$, there exists a set $P_0 \subset P$ containing p_0 in its convex hull and vectors v_p normal to ∂P at p $(p \in P_0)$ such that an affine functional on $\mathbb{R}^n$ separates a from any of the functions b_{p+v_p}, $p \in P_0$.

Room: *KC1.37* Time: *WED 11:15–12:00*

Continuing horrors of topology without Choice

Ian J. Tree
(Cheltenham, United Kingdom)

It is well known that Tychonoff's Theorem for compact spaces is equivalent to the Axiom of Choice and that the Baire Category Theorem is equivalent to Dependent Choice.

Objections could be raised against the use of Choice because of counter-intuitive consequences, such as the Banach-Tarski paradox. Equally, the absence of Choice leads to disturbing consequences. For instance, van Douwen has given an example consistent with ZF of a topological space which is not normal, yet which is orderable and the topological sum of compact metrizable spaces.

We examine various topological results in models of Zermelo-Fraenkel set-theory. It is shown that Urysohn's Lemma is not a theorem of ZF, whereas Urysohn's Metrization Theorem is. The space ω_1 can be paracompact, but can never be metrizable.

Room: *F 1.53* Time: *WED 15:30–15:50*

Maps of graphs with hereditarily indecomposable limits

H. M. Tuncali
(Nipissing University, North Bay, Canada)

Let G be a compact connected graph with a convex metric ρ. Suppose that a piecewise linear surjection $f : G \to G$ satisfies the following conditions.

a. There is a constant $\lambda > 1$ and $\beta > 1$ such that any nondegenerate subcontinuum A of G with $\mathrm{diam}_\rho(A) < \beta$ satisfies $\mathrm{diam}_\rho((f(A)) \geq \lambda \cdot \mathrm{diam}_\rho(A)$.
b. For each nondegenerate subcontinuum A of G, there is a positive integer n such that $f^n(A) = G$.

We prove that for each $\epsilon > 0$, there is a map $h_\epsilon : G \to G$ which is ϵ-close to f such that the inverse limit (G, h_ϵ) is hereditarily indecomposable.

Joint work by: K. Kawamura and H. M. Tuncali

Room: *KC 1.59* Time: *THU 13:55–14:15*

New Results on Connectedness

Reino Vainio
(Abo Akademi, Abo, Finland)

Connectedness arguments have "always" been used in order theory and category theory.

We suggest several new types of connectedness in ordered topological spaces, such as path-connectedness, link-connectedness and l-connectedness. As a useful framework of these studies, the concept of "connectivity system" is introduced. We study completeness conditions as well, relating them to connectedness concepts of ordered topological spaces.

We present a new concept of connectivity with application in all categories where function space objects (denoted by $C_c(S,T)$) satisfy natural exponential laws, as in cartesian closed categories. More precisely, an object S is called *cT-connected*, when $C_c(S,T)$ is isomorphic to T. We also motivate the development of a homotopy theory for spaces of real-valued continuous maps endowed with the structure of continuous convergence.

Part of the talk is joint work with Marcel Erné.

Subject Classification: 54C35, 54D05, 54F05, 54A20, 18D15, 06B30, 06F30

Room: *F 1.53* Time: *THU 9:50–10:10*

Classical-type characterizations of non-metrizable $AE(n)$-spaces

Vesko Valov
(University of Zimbabwe, Harare, Zimbabwe)

This is a joint paper with V. Gutev. The Kuratowski-Dugundji theorem states that a metrizable space X is an absolute extensor for n-dimensional metrizable spaces if and only if X is LC^{n-1} and C^{n-1}. In this form the above result fails when X is not metrizable. Concerning the non-metrizable absolute extensors for n-dimensional spaces (br., $AE(n)$), almost all their characterizations are in terms of inverse systems with n-soft maps (see [Ch], [Dr], [Sc]). These type-characterizations imply, in particular, that each non-metrizable $AE(n)$ is certainly LC^{n-1} and C^{n-1}. So, the following question arises: Can non-metrizable $AE(n)$'s be characterized by properties of the sort of LC^{n-1} and C^{n-1}? Only one result in this direction is known to the authors (see [Sh]). The property of a space X to be LC^{n-1} and C^{n-1} is equivalent to the existence of a " LC^{n-1} and C^{n-1}" base for X. Such bases satisfying, in addition, an assumption of regularity are used in [Sh] for a characterization of the compact $AE(n)$'s between the compact $AE(0)$'s. Since every metrizable space is an absolute extensor for 0-dimenstional metrizable spaces, Shirokov's result agrees with the classical one. To extend in such a manner the Kuratowski-Dugundji theorem over all $AE(n)$'s and to show how the resulting theorems can be used is the purpose of this talk.

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Subject Classification: primary: 54C55, 54F35; secondary: 54C20, 54F65

Joint work by: V. Gutev and V. Valov

Room: *F 1.53* Time: *WED 11:40–12:00*

On $X \times Y$, where Y is a compact space with countable tightness, and X is a countably compact GO-space.

Jerry E. Vaughan
(University of North Carolina at Greensboro, Greensboro, NC, USA)

We consider $T_{3.5}$-spaces. M. V. Matveev defined a space X to be *absolutely countably compact (acc)* provided for every open cover $\mathcal{U}$ of X and every dense $D \subset X$, there exists a finite set $F \subset D$ such that $\bigcup\{U \in \mathcal{U} : U \cap F \neq \emptyset\} = X$. It is known that $X \times Y$ is acc provided Y is compact and sequential, and X is acc. We consider the question: can countable tightness replace sequential in this result? The answer is "yes" under PFA by the well-known theorem of Z. Balogh [PAMS **105** (1989) 756-764] which says: (PFA) every compact Hausdorff space of countable tightness is sequential. What happens in models of $\diamondsuit$? Is there an acc space X whose product with Y^*, the one-point compactification of Ostaszewskii's space, is not acc. We show that such a space X cannot be a generalized ordered space.

Theorem. *If X is a countably compact GO-space, then $X \times Y^*$ is acc.*

Corollary. *Every countably compact GO-space is acc.*

Room: *KC 1.59* Time: *THU 9:25–9:45*

Local homotopy properties of topological embeddings in codimension two

Gerard A. Venema
(Calvin College, Grand Rapids, MI, USA)

Suppose N is an $(n-2)$-manifold topologically embedded in an n-manifold M. Chapman and Quinn have shown that N is locally flat in M provided that the local homotopy groups of $M-N$ at points of N are infinite cyclic and that all the higher local homotopy groups of $M-N$ at points of N vanish. The main theorem in this paper asserts that *it is only necessary to assume the homotopy conditions in dimensions below the middle dimension*; i.e., if the local fundamental groups of the complement are good and if $M-N$ is locally k-connected at points of N for $2 \leq k < n/2$, then N is locally flat.

Various examples and results will be presented which show that the theorem is best possible.

Room: *M 1.29* Time: *WED 15:55–16:15*

Relations between fixed points of $f : X \to X$ and $\beta f : \beta X \to \beta X$

J. Vermeer

(Technische Universiteit, Delft, the Netherlands)

A. Krawczyk and J. Steprāns proved for the class of σ-compact and zerodimensional spaces:

> $f : X \to X$ has no fixed points if and only if $\beta f : \beta X \to \beta X$ has no fixed points.

The same problem for the class of σ-compact and finite-dimensional spaces is still open. Some non-trivial "corollaries" of this open question will be discussed and proved to be correct. As an example it will be proved that:

> if X is compact and the dimension of X is at most n then every map $f : X \to X$ without fixed points has a cover $A_1, \ldots, A_{2n+3}$ of closed sets of X with $f(A_i) \cap A_i = \emptyset$, for all j.

Room: *KC 1.37* Time: *THU 9:50–10:10*

On $(\mathcal{D}, \mathcal{E})$-analytic sets

Eliza Wajch
(University of Łódź, Łódź, Poland)

An abstract concept of $(\mathcal{D}, \mathcal{E})$-analytic sets is introduced and applied to characterizations of normality, perfect normality and Oz-spaces, as well as to giving some necessary and sufficient conditions for two sets of functions to generate the same compactification of a pseudocompact space. A metrization theorem for pseudocompact spaces is deduced.

Subject Classification: 54H05, 54D30, 54D15, 54D35.

Room: *M 1.29* Time: *WED 10:50–11:10*

Resolutions: some more Theory and its Applications to Continuum Theory, Geometric Topology and Dynamical Systems

Stephen Watson
(York University, North York, Canada)

In recent lectures in Kobe, Trieste and Auburn, we presented the *resolution* of a topological space. This method, introduced originally by Fedorčuk in 1968, is a fundamental one in topology. Indeed the combination of resolution, inverse limit, and subspace is the natural topological expression of the theme that complicated structures can be usefully approximated by simple ones. A huge array of spaces can be constructed by resolving elementary spaces such as the closed unit interval or the unit square by means of fairly elementary functions, and then taking some fairly natural subspace. Such spaces include the Alexandroff duplicate, the double arrow space, the lexicographically ordered square, the Peano curve, the Niemytski plane, the butterfly space, and the Prüfer manifold. For a detailed exposition, see *The Construction of Topological Spaces: Planks and Resolutions*, pp. 673–759, Recent Progress in General Topology, ed. M. Hušek, J. van Mill, North-Holland, Amsterdam, 1993.

In this talk, we present some natural extensions of this idea. We show that resolutions can be defined by lower semicontinuous multifunctions rather than (single-valued) continuous functions and that these are precisely the inverses of fully closed maps. We define a resolution in which closed sets are resolved rather than points and show that some difficult examples in continuum theory and geometric topology can be substantially simplified using this idea: in particular, we exhibit an explicit natural relationship between Antoine's necklace and the Alexander horned sphere. We discuss the close relationship between a method used by Mardesic as early as 1960, Pasynkov's partial topological products and resolutions. We show that (extended) resolutions can even be used to define compact metric manifolds. We show that resolutions can be used to give a more explicit statement of the Caratheodory prime end theorem and to define interesting boundary behaviour for dynamical actions on the open disk.

Room: *KC 1.37* Time: *THU 14:50–15:10*

Some Compact Monotonically Normal Spaces

Scott W. Williams
(S.U.N.Y/Buffalo, NY, USA)

We show that members of a certain subclass of the compact monotonically normal spaces are all continuous images of compact orderable spaces.

Room: *KC 1.37* Time: *THU 9:00–9:20*

Decomposing Homeomorphism of the Hilbert Cube

Raymond Y. Wong
(UCSB, Santa Barbara, CA, USA)

For a fix integer $n > 0$, let $\mathcal{H}_\partial(B)$ denote the space of homeomorphisms of the n-cube B which leaves the boundary of B pointwise fixed. We consider B as the subset $B \times (0, 0, \ldots)$ in the Hilbert cube $Q = [0, 1]^\infty$, each $h \in \mathcal{H}_\partial(B)$ is regarded as a homeomorphism $h \times id$ in $\mathcal{H}_\partial(Q)$. It is well known that $H_\partial(Q)$ is an ℓ_2-manifold. An important unsolved problem is whether $\mathcal{H}_\partial(B)$ is an ℓ_2-manifold, or, equivalently, whether $\mathcal{H}_\partial(Q)$ retracts onto $\mathcal{H}_\partial(B)$.

In this paper we study the following two subspaces of $\mathcal{H}_\partial(Q)$:

$\mathcal{B}$ = the set of homeomorphisms each of which leaves the subset B invariant and
$\mathcal{C}$ = the set of homeomorphisms each of which moves points only in the i-direction, for some $i > n$.

Using an engulfing technique developed in earlier papers, we show, among other results, that

Theorem. *Every $h \in \mathcal{H}_\partial(Q)$ can be approximated by one that decomposed into $h_1 h_2 h_3 \ldots h_m$, where each $h_i \in \mathcal{B} \cup \mathcal{C}$.*

Room: *M 1.29* Time: *WED 16:50–17:10*

Closure-preserving covers by nowhere dense sets

Yukinobu Yajima
(Kanagawa University, Yokohama, Japan)

All spaces are assumed to be regular T_1.

Theorem 1. *Every dense in itself space has a dense subspace with a closure- preserving cover by nowhere dense sets.*

Theorem 2. *A Baire space has a closure-preserving cover by nowhere dense sets if and only if it has a σ-closure-preserving cover by nowhere dense sets.*

Theorem 3. *No G_δ-set in a countably compact space has a closure-preserving cover by nowhere dense sets.*

Corollary 4. *Neither Čech-complete spaces nor countably compact spaces have a σ-closure-preserving cover by nowhere dense sets.*

Theorem 5. *A space X is κ-subparacompact if and only if every binary open cover of $X \times 2^\kappa$ has a σ-closure-preserving refinement by closed rectangles.*

Joint work by: Toshiji Terada and Yukinobu Yajima

Room: *F 1.53* Time: *WED 16:50–17:10*

On the group of S^1-equivariant homeomorphisms of the 3-sphere

Tsuneyo Yamanosita
(Musashi Institute of Technology, Tokyo, Japan)

Let S^1 act on S^3 as usual. Denote by $\mathrm{Top}_{S^1}(S^3)$ the group of equivariant homeomorphisms of S^3. Then we have the following homotopy equivalence:

$$\mathrm{Top}_{S^1}(S^3) \equiv (S^3 \times S^1)/\mathbb{Z}_2.$$

Room: *M 1.29* Time: *WED 16:20–16:40*

Containing planar rational space for the family of planar rational compacta

S. Zafiridou
(University of Patras, Patras, Greece)

We construct a simple, direct and visualized example of a planar rational connected and locally connected space, which is a containing space for all planar rational compacta.

Joint work by: S. Iliadis, L. Feggos and S. Zafiridou

Room: *KC 1.59* Time: *THU 14:25–14:45*

Extending invariant measures on topological groups

Piotr Zakrzewski
(University of Warsaw, Warsaw, Poland)

Let G be an uncountable group.

The aim of the talk is to address the question, whether every invariant σ-finite measure on G has a proper invariant extension. Harazišvili and, independently, Erdős and Mauldin proved that if $m : \mathcal{A} \to \mathbb{R}_+$ is such a measure, then $\mathcal{A} \neq \mathcal{P}(G)$ i.e., the measure m is not *universal* on G. One would like to know if there is, moreover, a *proper invariant extension* of m i.e., a measure $m' : \mathcal{A}' \to \mathbb{R}_+$ such that $\mathcal{A}' \subseteq \mathcal{A}'$, $\mathcal{A}' \neq \mathcal{A}$ and $m' \restriction \mathcal{A} = m$.

All measures considered here are assumed to be σ-additive, extended real-valued, diffused and σ-finite.

We will say that a group G satisfies the *Measure Extension Property, MEP*, if every invariant measure on G has a proper invariant extension.

By an old result of Hulanicki, if there is no real-valued measurable cardinal $\leq |G|$, then G satisfies MEP. Pelc proved that all abelian groups satisfy MEP and conjectured that in fact *all* groups do. Though it is now known that some other algebraically defined classes of groups satisfy MEP, the question, wether Pelc's conjecture is true, remains a major open problem.

In this talk G is assumed to be a Hausdorff topological group.

Our results are as follows.

Theorem 1. *If G is Polish and not locally compact, then G satisfies MEP.*

Theorem 2. *If G is compact and not zero-dimensional, then G satisfies MEP.*

Theorem 3. *If G is the product of a sequence $\langle G_n : n < \omega \rangle$ of finite groups with the property that there is a finite constant N such that $1 < |G_n| < N$ for each $n < \omega$, then G satisfies MEP.*

Room: *F 1.53* Time: *WED 11:15–11:35*

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